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NATIONAL DAM SAFETY PROGRAM. STRUCTURE E-1 (MO 20511), VERDIGRI--ETC(U)
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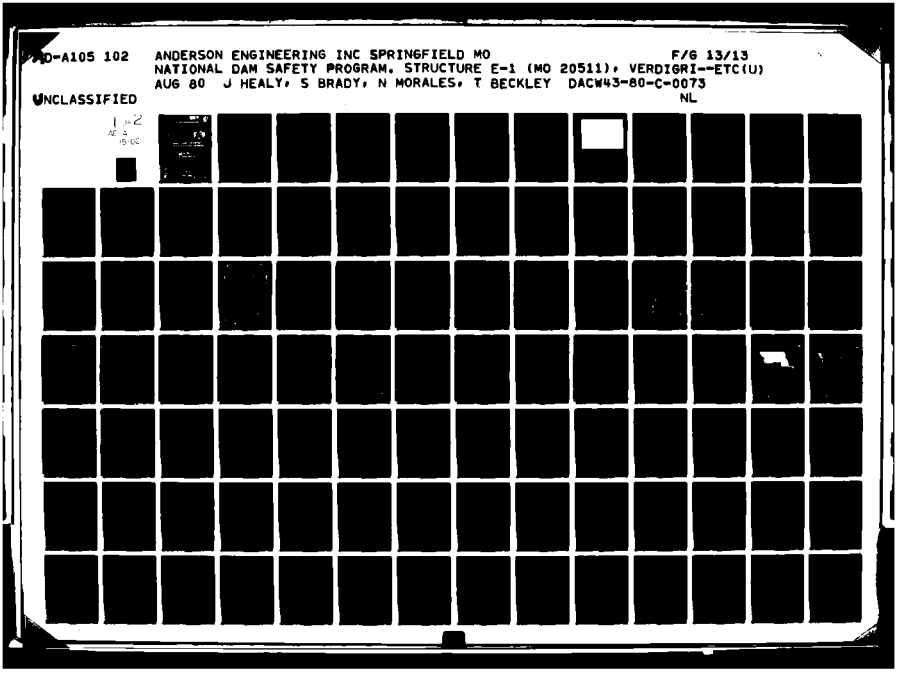

VERDIGRIS-NEOSHO [illegible]

STRUCTURE E-1

NEWTON COUNTY, MISSOURI

MO 20[illegible]1

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
Serving the Army

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST, 1980

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Structure E-1
Newton County, Missouri
Missouri Inventory No. 20511

This report presents the results of field inspection and evaluation of the Structure E-1. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

17 SEP 1980
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

18 SEP 1980
Date

VERDIGRIS-NEOSHO RIVER BASIN

STRUCTURE E-1
NEWTON COUNTY, MISSOURI
MISSOURI INVENTORY NO. 20511

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

AUGUST, 1980

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam: Structure E-1
State Located: Missouri
County Located: Newton
Stream: Tributary of Lost Creek
Date of Inspection: May 28, 1980

Structure E-1 was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of this inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 2 miles downstream of the dam. Located within this zone are approximately 6 dwellings, 6 buildings and a railroad.

The dam is in the intermediate size classification, since it is greater than 40 ft high but less than 100 ft high. The maximum storage capacity is greater than 50 ac-ft but less than 1000 ac-ft.

Our inspection and evaluation indicate that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 70 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteoroligic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of intermediate size with a high downstream hazard potential pass the PMF.

The PMF has been determined to be the appropriate spillway design flood. The 1 percent probability flood will not overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being exceeded in any given year.

Deficiencies visually observed by the inspection team were: (1) Standing water on the downstream berm; (2) standing water at the downstream toe of embankment, and (3) some erosion on the embankment slopes.

Another deficiency was the lack of seepage and stability analysis comparable to the requirements of the recommended guidelines.

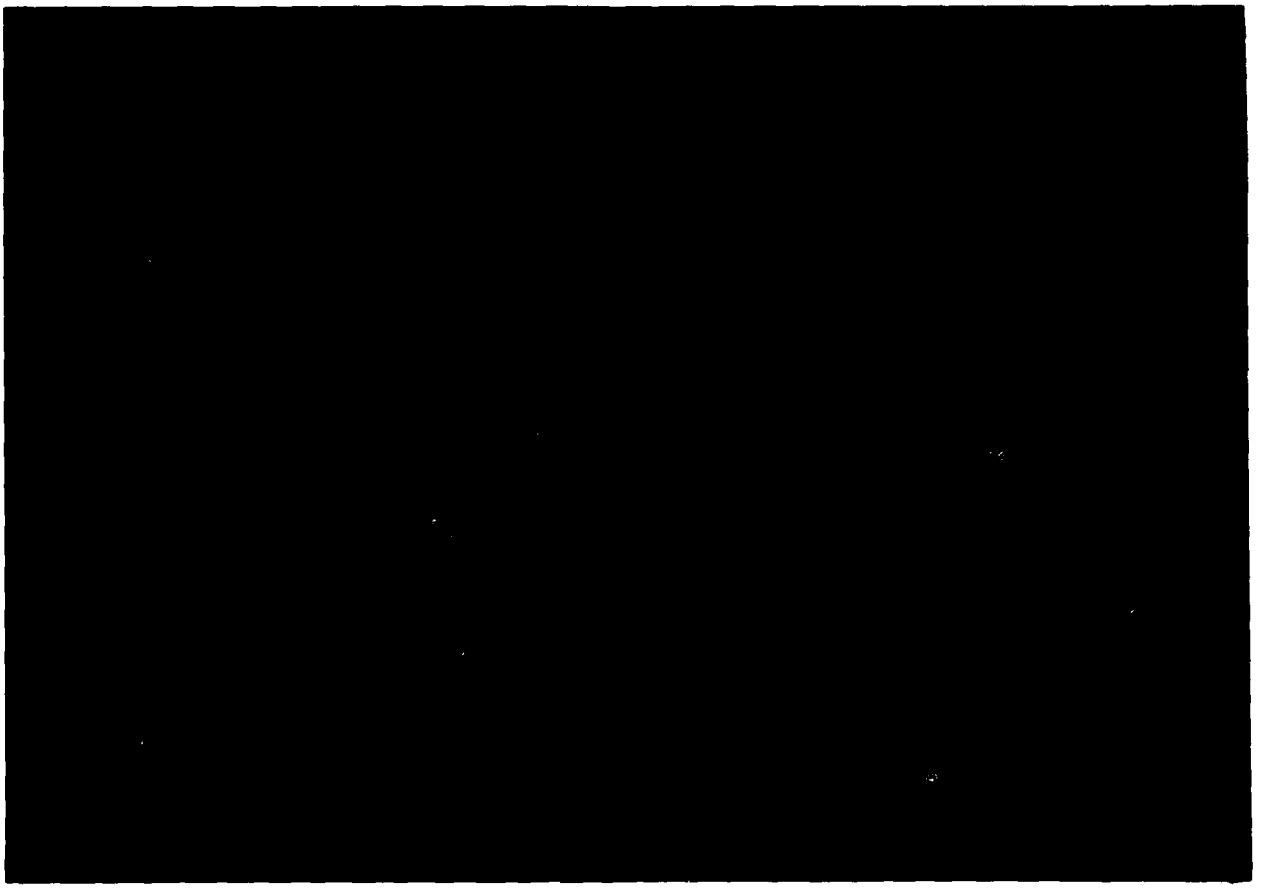
It is recommended that the owners take the necessary action without undue delay to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

Jack Healy, P.E.
Hanson Engineers, Inc.

Steve Brady, P.E.
Anderson Engineering, Inc.

Nelson Morales, P.E.
Hanson Engineers, Inc.

Tom Beckley, P.E.
Anderson Engineering, Inc.



AERIAL VIEW OF LAKE AND DAM

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
STRUCTURE E-1 ID NO. 20511

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APPENDICES

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Structure E-1 in Newton County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Structure E-1 is an earth fill structure approximately 45 ft high and 735 ft long at the crest. The appurtenant work consists of a 30 inch diameter reinforced concrete primary spillway pipe with a reinforced concrete flow riser and an earth cut swale located at the west abutment.

Sheet 3 of Appendix A shows a plan, profile and typical section of the embankment as obtained from field inspection data. Sheets 6 through 11 of Appendix A are selected As Built drawings obtained from the U. S. Department of Agriculture, Soil Conservation Service, Columbia, Missouri.

B. Location:

The dam is located in the west-central part of Newton County, Missouri on a tributary of Lost Creek. The dam and lake are within the Racine, Missouri 7.5 minute quadrangle sheet (Section 16, T25N, R33W - latitude 36°53.5', longitude 94°32.4'). Sheet 2 of Appendix A shows the general vicinity. Sheet 5 of Appendix A is the Project Map developed as part of the Work Plan for Watershed Protection and Flood Prevention for the Lost Creek Watershed prepared by the Soil and Water Conservation District of Newton County.

C. Size Classification:

With an embankment height of 45 ft and a maximum storage capacity of approximately 700 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately 2 miles downstream of the dam. Located within this zone are approximately 6 dwellings, 6 buildings and a railroad. The location of most of the above were verified by the inspection team.

E. Ownership:

The dam is owned by the Lost Creek Watershed Subdistrict, Jim Stone, Chairman, P. O. Box 149, Neosho, Missouri 64850; and is on property owned by Mr. Gus Buzzard, Route 2, Neosho, Missouri 64850.

F. Purpose of Dam:

The dam was constructed under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Statute 666) as amended primarily for the purpose of a Floodwater Retarding Structure for the Lost Creek Watershed, Newton County, Missouri.

G. Design and Construction History:

The dam was designed by the U. S. Department of Agriculture, Soil Conservation Service, Columbia, Missouri, under the Authority of the Watershed Protection and Flood Prevention Act. Prior to the design of the dams, a watershed work plan for the Lost Creek Watershed was prepared in January, 1971, by the Soil and Water Conservation District of Newton County with assistance by SCS. A partial set of As Built Plans are included as Sheets 6 through 10 of Appendix A. A complete set of plans are available through the Columbia, Missouri office of SCS.

Geologic Investigation and analysis completed by SCS are included as Sheets 3 through 42 of Appendix B. A Geologic Report prepared by the State of Missouri Geology and Land Survey Section is included as Sheet 43.

The contract for construction was let on July 22, 1977, for Newton County Structure E-1.

Inspection of the project was conducted under the control of Mr. Joe Green, Project Engineer, Soil Conservation Service, Mount Vernon, Missouri. Results of the inspection and testing including inspector's field notes, compaction and concrete reports, are currently on file in the Columbia, Missouri SCS office.

The contractor for the project was Don Stewart Construction Company, Joplin, Missouri. Construction commenced in October, 1977, and the dam was completed in August, 1979.

Mr. Buzzard, a retired contractor, observed the daily progress of the construction. He stated that the dam was built in general conformance with the plans with the exception of the modification of the internal drainage system near Spring #2 (See Sheet 9 of Appendix A). An additional drainage system through the embankment was deemed necessary after the core trench was excavated and Spring #2 area was cleaned out. Mr. Buzzard indicated that the numerous springs in the embankment area drain to the toe area and the resulting flow moves to the downstream channel near the toe. He stated that one spring, previously used for watering purposes, has not cleared up since construction of the dam.

During construction of the dam, a channel approximately 100 ft in width at the east abutment was constructed to carry the flow. As the dam neared completion, the flow was diverted to the inlet structure and fill material compacted in the previously used channel.

Mr. Buzzard indicated that the downstream berm was extended in length to the west due to the excess rock removed during construction. He stated that 102 days after the spillway slide gate was closed, water flowed through the upper orifice into the spillway pipe.

H. Normal Operating Procedures:

All flows will normally be passed by the restricted flow riser to the 30 inch spillway pipe and the uncontrolled earth cut emergency spillway. Information obtained from Mr. Green and Mr. Buzzard indicates that the maximum pool level for this dam was approximately 6 inches above the upper orifice inlet. The emergency spillway has never been used.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment from field data obtained by the inspection team. Sheets 6 through 11 of Appendix A are selected sheets from the complete set of As Built plans prepared by the Soil Conservation Service.

A. Drainage Area:

The drainage area for this dam, as obtained from the Watershed Work Plan and As Built Plans (Sheet 11 of Appendix A) is approximately 736 acres.

B. Discharge at Dam Site:

(1) All discharge at the dam site is through the restricted flow riser for the 30 inch diameter principal spillway pipe and an uncontrolled earth cut emergency spillway.

(2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 1002.9): 4918 cfs

(3) Estimated Capacity of Principal Spillway: 68 cfs

(4) Estimated Capacity of Emergency Spillway: 4850 cfs

(5) Estimated Experienced Maximum Flood at Dam Site: Unknown

(6) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable

(7) Diversion Tunnel Outlet at Pool Elevation: Not Applicable

(8) Gated Spillway Capacity at Pool Elevation: Not Applicable

(9) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level elevation of 1005.3 for B.M. #1, described in As Built Plans as concrete monument 50 ft left of Sta. 0 + 00 centerline of dam. (See Sheet 6 of Appendix A).

(1) Top of Dam: 1002.9 (low point), 1004.8 (hight point)

(2) Principal Spillway Crest: 975.6 feet MSL

(3) Emergency Spillway Crest: 996.4 feet MSL

(4) Principal Spillway Pipe Invert Elevation at Outlet: 959.5 feet MSL

(5) Streambed at Centerline of Dam: 960.0 feet MSL

(6) Pool on Date of Inspection: 975.7 feet MSL

(7) Apparent High Water Mark: 976.2 feet MSL

(8) Maximum Tailwater: None

(9) Upstream Portal Invert Diversion Tunnel: Not Applicable

(10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Top of Dam: 3000 Feet

(2) At Principal Spillway Crest: 900 Feet

(3) At Emergency Spillway Crest: 2500 Feet

E. Storage Capacities:

(1) At Principal Spillway Crest: 60 Acre-Feet

(2) At Top of Dam: 700 Acre-Feet

(3) At Emergency Spillway Crest: 465 Acre-Feet

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 9.5 Acres

(2) At Top of Dam: 41.5 Acres

(3) At Emergency Spillway Crest: 31.5 Acres

G. Dam:

(1) Type: Earth

(2) Length at Crest: 735 Feet

(3) Height: 45 Feet

(4) Top Width: 14 Feet

(5) Side Slopes: Upstream 1V:3.0H; Downstream varies from 1V:3.0H to 1V:2.5H

(6) Zoning: Gravelly Silt and Clay

(7) Impervious Core. 12 Feet Wide

(8) Cutoff: 8 Feet Below Base of Dam

(9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

(1) Type: Not Applicable

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

(1) Location: Centerline Dam Station 1 + 90

(2) Type: 30 Inch Diameter Reinforced Concrete Pipe with Restricted Flow Riser

I.2 Emergency Spillway:

(1) Location: West Abutment

(2) Type: Earth Cut Swale, 100 ft wide with 1V:3H side slopes

(3) Upstream Channel: Grass covered earth channel

(4) Downstream Channel: Grass covered channel with moderate slope

J. Regulating Outlets:

The 12 inch diameter slide gate associated with the restricted flow riser is the only regulating outlet feature of the dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

Design calculations and construction plans were prepared by and are currently on file with the U. S. Department of Agriculture Soil Conservation Service in Columbia, Missouri. A partial set of these plans are included as Sheets 6 through 11 of Appendix A. A Watershed Work Plan was prepared for the Lost Creek Watershed prior to the design phase. A copy of the Project Map is included as Sheet 5 of Appendix A. This plan, prepared under the Authority of Public Law 566, is also on file in the Columbia SCS office.

A. Surveys:

A topographic survey was conducted by the Soil Conservation Service for the Lost Creek watershed. The survey was tied to the sea level datum, and temporary benchmarks were located at each dam site. Concrete monuments were set at each end of the embankment by SCS. A description of these benchmarks is shown on Sheet 6 of Appendix A. From the topographic survey data a 4 foot contour interval map was drawn for design purposes.

B. Geology and Subsurface Materials:

The site is located in the border zone between the Ozarks and Western Plains geologic regions of Missouri. This area is characterized topographically by rolling to hilly with oak and hickory forest areas. The sedimentary rock layers exposed in the Ozarks region dip downward away from the Ozarks region and the higher and younger sedimentary deposits become the surface ledges in southwest Missouri. The soils in this region are residual from cherty and dolomitic limestones of the Mississippian age. The site is located upon an outcrop of the Warsaw formation of the Meramecian series. The limestone bedrock occurs at an average depth of 10 feet below initial ground level along the entire dam centerline, as described in the Geologic Report on the site. The Geologic Report prepared by the Soil Conservation Service is contained in Appendix B.

Soils in the area of the dam are one of this area's most common soils. The embankment soils are reddish-brown silty clays (CL) with chert rock fragments. The chert is from the parent material and is found in each of the soil layers of this soil series. These soils generally make good fill material when properly compacted.

The "Geologic Map of Missouri" indicates that two known faults run in a northeast-southwesterly direction through or very near the dam site. The Missouri Geological Survey has indicated that these faults are known as the Seneca faults and there is no known activity or movement. These faults in this area are generally considered to be inactive. The publication "Caves of Missouri" indicates there are four caves in Newton County and these are several miles from the dam site.

C. Foundation and Embankment Design:

Included as Sheet 3 of Appendix B is the Geologic Investigation of Dam Site for this structure. The profile at the centerline of the dam shows the location of the borings as obtained by SCS. Sheets 4 through 42 of Appendix B are the detailed soil investigation with conclusions from the study.

Based upon the available information, the basic foundation soil appears to be silty clays (CL). There is apparently no particular zoning of the embankment. Sheet 9 of Appendix A is the As Built drainage system for this structure. The drainage system in the area of Spring #2 was modified in the field according to Mr. Green. Modification #2 was the installation of an intermediate drain outlet through the embankment.

During construction of the dam, the Soil Conservation Service added to the contract the placement of three piezometers. The location of these piezometers are as shown on Sheet 3 of Appendix A. They are usually checked weekly and after each storm. The record of the piezometer readings are maintained in the Columbia, Missouri, Soil Conservation Service Office.

D. Hydrology and Hydraulics:

The hydrologic and hydraulic design parameters of this dam are as shown on Sheet 11 of Appendix A. The Soil Conservation Service surveyed 17 valley cross-sections in the watershed and routed 8 evaluation storms through the channel using the T. R. 20 computer program. Assistance was obtained from the Tulsa District, Corps of Engineers for the study and evaluation. Based on the As Built Plans and a field check of spillway dimensions and embankment evaluations and a check of the drainage area on U.S.G.S. quad sheets, hydrologic analysis using U. S. Army Corps of Engineers guidelines was performed and appear in Appendix C as Sheets 1 through 9.

E. Structure:

The only structure associated with this dam is the restricted flow riser. Details of this riser appear as Sheet 10 of Appendix A.

2.2 CONSTRUCTION:

Inspection during the construction of the dam was performed by the Soil Conservation Service Office, Mount Vernon, Missouri, under the direction of Mr. Joe Green, Project Engineer. Mr. Green stated that daily inspection was performed during construction. The inspector's log and inspection tests, to include compaction and concrete testing, are currently on file at the Soil Conservation Service Office, Columbia, Missouri. The construction inspection data were not obtained.

2.3 OPERATION:

Normal flows would be passed by the restricted flow riser to the 30 inch diameter spillway pipe and the uncontrolled earthcut spillway.

2.4 EVALUATION:

A. Availability:

The engineering data available are as listed in Section 2.1.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. The seepage analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

The As Built Plans and Soil Investigation data and test results prepared by the Soil Conservation Service included in Appendices A and B are valid engineering data on the design and construction of the dam.

SECTION 3 - VISUAL INSPECTON

3.1 FINDINGS:

A. General:

The field inspection was made on May 28, 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri, and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc., (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc., (Civil Engineer)
Jack Healy - Hanson Engineers, Inc., (Geotechnical Engineer)
Nelson Morales - Hanson Engineers, Inc., (Hydraulic Engineer)

Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The dam appears to be in good condition. No sloughing or sliding of the embankment was noted. The horizontal and vertical alignments of the crest were good, and no surfacing cracking or unusual movement was obvious. The crest of the embankment was 14 feet wide and the low crest elevation was 1002.9. The field survey data obtained by the inspection team compared favorably to the As Built Plans for this dam.

On the date of inspection, the pool level was about 0.1 feet above the upper orifice invert. The apparent high water mark observed on the riser structure was about 6 inches higher than normal pool elevation.

Shallow auger probes into the embankment indicated the fill material to be a reddish brown silty clay (CL). The embankment has a good grass cover and appears to be in good condition. Some erosions was observed in some areas of the embankment where the grass cover is light. No sloughing of the embankment or seepage through the embankment was evident. No animal burrows were noted.

Water was observed along the toe of the embankment. The water appeared to be from the installed drains and the spring along the toe of the embankment. The standing water on the downstream berm appeared to be due to inadequate surface drainage provided for the berm.

No rip rap was noted on the upstream face of the embankment at normal pool level.

The water level of the three piezometers was checked by the inspection team. The water elevations are recorded on Sheet 3 of Appendix A.

Benchmark #1 (See Sheet 6 of Appendix A) was used as the datum for the field survey.

C. Appurtenant Structures:

C.1 Principal Spillway:

The principal spillway consisting of the 30 inch reinforced concrete spillway pipe and associated flow restrictor riser is in good condition. The 12 inch diameter slide gate appeared to be in good working condition.

The approach to the inlet structure was clear. Considerable rip rap was placed around the inlet structure.

C.2 Emergency Spillway:

The emergency spillway was located at the west abutment. The spillway channel appeared to be an earth cut channel. The grass cover in the channel was good with some erosion channels observed. The spillway has not been used since the dam was constructed. Continued use of the spillway would probably result in erosion of the topsoil.

The outlet channel is directed well away from the embankment. The outlet and inlet channel were clear.

D. Reservoir.

The immediate periphery of the lake was wooded and grass covered with moderate slopes. The reservoir banks appeared to be in good condition with good grass cover. No appreciable sedimentation was noted.

E. Downstream Channel:

Immediately downstream of the embankment the channel is grass covered. The downstream channel is tree lined with moderate slope.

3.2 EVALUATION.

The grass cover on the embankment was fair to good with some erosion channels in the areas of light grass cover. No apparent seepage was observed, although standing water was present along the downstream toe and on the downstream berm.

No significant erosion was observed on the front face of the embankment at normal pool level.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

The operation and maintenance of the dam are the responsibility of the Lost Creek Watershed District Board in conjunction with the Soil and Water Conservation District, Neosho, Missouri. For the first three years after construction of the dam, a joint inspection is being conducted by members of the District Board and the Soil Conservation Service. After three years the District Board is responsible for providing yearly inspections. In addition to the annual inspection, the dam is to be inspected after each severe flood and after the occurrence of any other unusual conditions which might adversely affect the structural measure. The inspection is to include the condition of principal spillway and its appurtenances, the emergency spillway, the earthfill and any other items installed as a part of the structure. Copies of the inspection report are forwarded to the Soil Conservation Service office in Springfield, Missouri. The last annual inspection was conducted on May 14, 1980, and the results are included as Sheet 12 of Appendix A.

4.2 MAINTENANCE OF DAM:

After the yearly inspection of the dam, the Lost Creek Watershed District Board determines the maintenance to be done. Monies for the required maintenance are derived from a tax levy imposed upon the residents of the Watershed District.

4.3 MAINTENANCE OF OPERATING FACILITIES:

The maintenance required for the restricted flow riser is accomplished after the yearly inspection by the Watershed District Board. The slide gate appeared to be in good condition.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The general maintenance of the dam and associated items appeared to be in good condition. The lack of wave protection near the upstream face was noted. Some erosion channels were forming in the area of light grass cover. Standing water was observed along the downstream toe and on the downstream berm.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

The hydrologic and hydraulic design data for this dam are as shown on Sheet 11 of Appendix A.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were obtained for this lake and watershed. During the design phase, flood frequency used in evaluation of damages was obtained from six representative stream gauges in the surrounding area.

C. Visual Observations:

The approach channels to the spillway are clear. The emergency spillway is well separated from the embankment, and spillway releases would not be expected to endanger the dam. Spillway flows through the principal spillway pipe could result in erosion of the downstream channel.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U. S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on (1) a field survey of spillway dimensions and embankment elevations; (2) an estimate of the reservoir storage and the pool and drainage areas from the Racine, Missouri, 7.5 Minute U.S.G.S. quad sheet, and (3) data obtained from the As Built Plans for this project (See Appendix A, Sheets 6 through 11).

Based on the hydrologic and hydraulic analysis presented in Appendix C, the combined spillways will pass 70 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass the PMF, without overtopping. The PMF has been determined to be the appropriate spillway design flood. The structure will pass a 1 percent probability flood without overtopping.

Application of the probable maximum precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 8781 cfs. For 50 percent of the PMP, the peak inflow was 4390 cfs.

The routing of the PMF through the spillways and dam indicates that the dam will be overtopped by 1.46 feet at elevation 1004.36. The duration of the overtopping will be 1.0 hours, and the maximum outflow will be 7507 cfs. The maximum discharge capacity of the spillways is 4918 cfs. The routing of 50 percent of the PMF indicates that the dam will not be overtopped. The maximum outflow will be 3166 cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

Design data obtained are included in Appendix A. Analysis of the soil structure is included in Appendix B. Additional design data and construction notes and test results are located at the Soil Conservation Service in Columbia, Missouri.

Seepage and stability analysis comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

The piezometers are normally read and recorded weekly and after each storm. The resulting readings are on file in the Columbia, Missouri Soil Conservation Service Office. Verbal information from that office indicated that the water elevations for the east piezometer were maximum 950.6 (April, 1980), minimum 948.4 (February, 1980), mean 949.5. The center piezometer was maximum 957.2 (May, 1980), minimum 955.6 (March, 1980), mean 956.5, the west piezometer was maximum 964.7 (April, 1980), minimum 963.7 (March, 1980), mean 964.2. On the date of inspection the elevations recorded were east piezometer - 948.8, center piezometer - 958.3 and west piezometer 960.7.

As the lake has been full for only about 6 months and rainfall has been slight, no noticeable trends have been observed by the Soil Conservation Service. Thus far the east piezometer appears to fluctuate depending upon the amount of rainfall.

D. Post-Construction Changes:

There have been no reported post construction changes to this dam.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is in good condition. Some items were noted during the visual inspection which should be investigated further, corrected or controlled. These items are: (1) standing water on downstream berm; (2) standing water along the downstream toe of embankment; and (3) some erosion on the embankment slopes.

Another deficiency was the lack of seepage and stability analyses comparable to the recommended guidelines.

The dam will be overtopped by flows in excess of 70 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on review of the information listed in Section 2.1, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will deteriorate and possibly could become serious in the future. The items recommended in paragraph 7.2A should be pursued without undue delay.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no additional inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

Spillway size and/or height of dam should be increased to pass the PMF. In either case, the spillway should be protected to prevent erosion.

B. O & M Procedures:

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.

(2) Vegetative growth on the dam should be maintained and cut annually.

(3) Wave protection should be provided for the upstream face of the embankment.

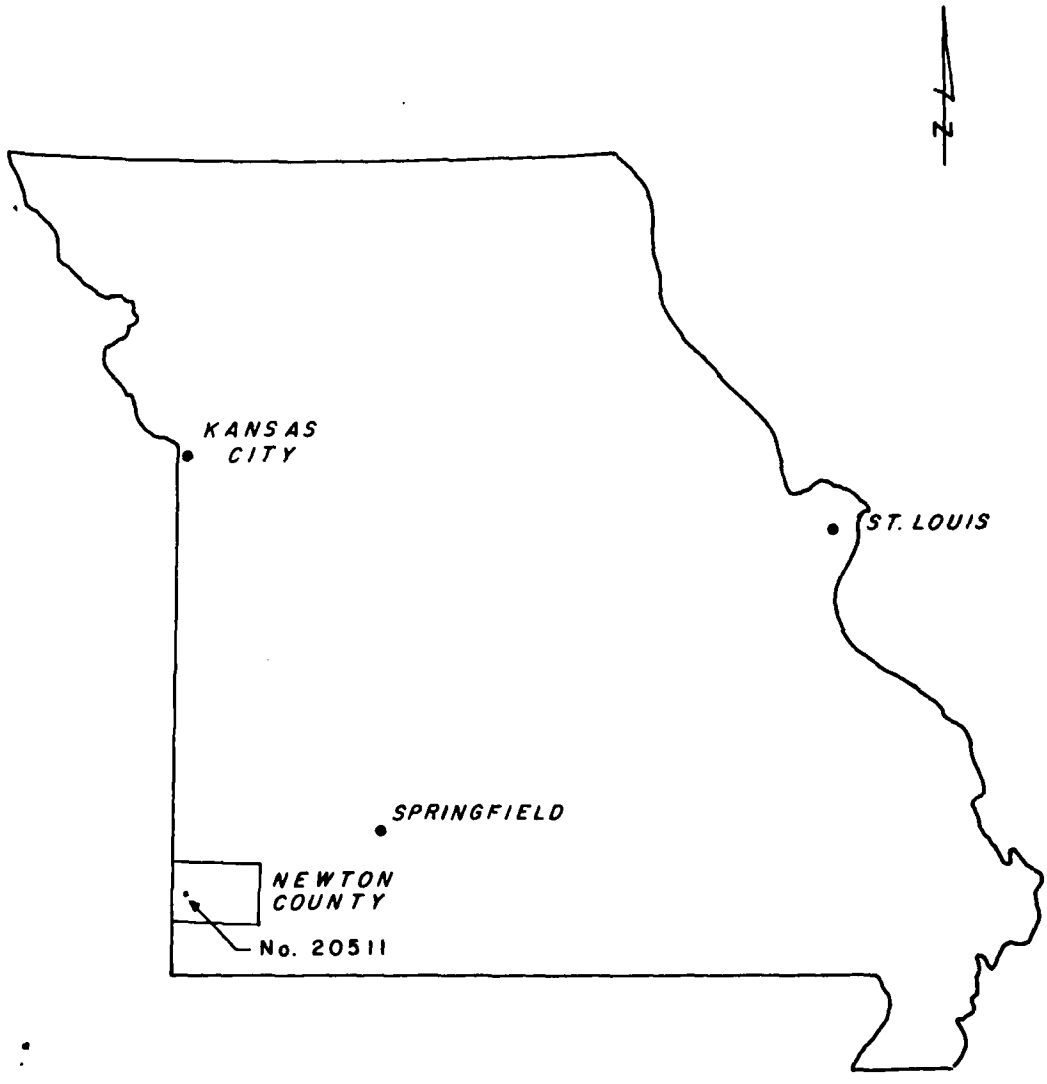
(4) the downstream berm should be graded to allow egress of surface water.

(5) The water at the downstream toe should be observed periodically to determine any increase in flow.

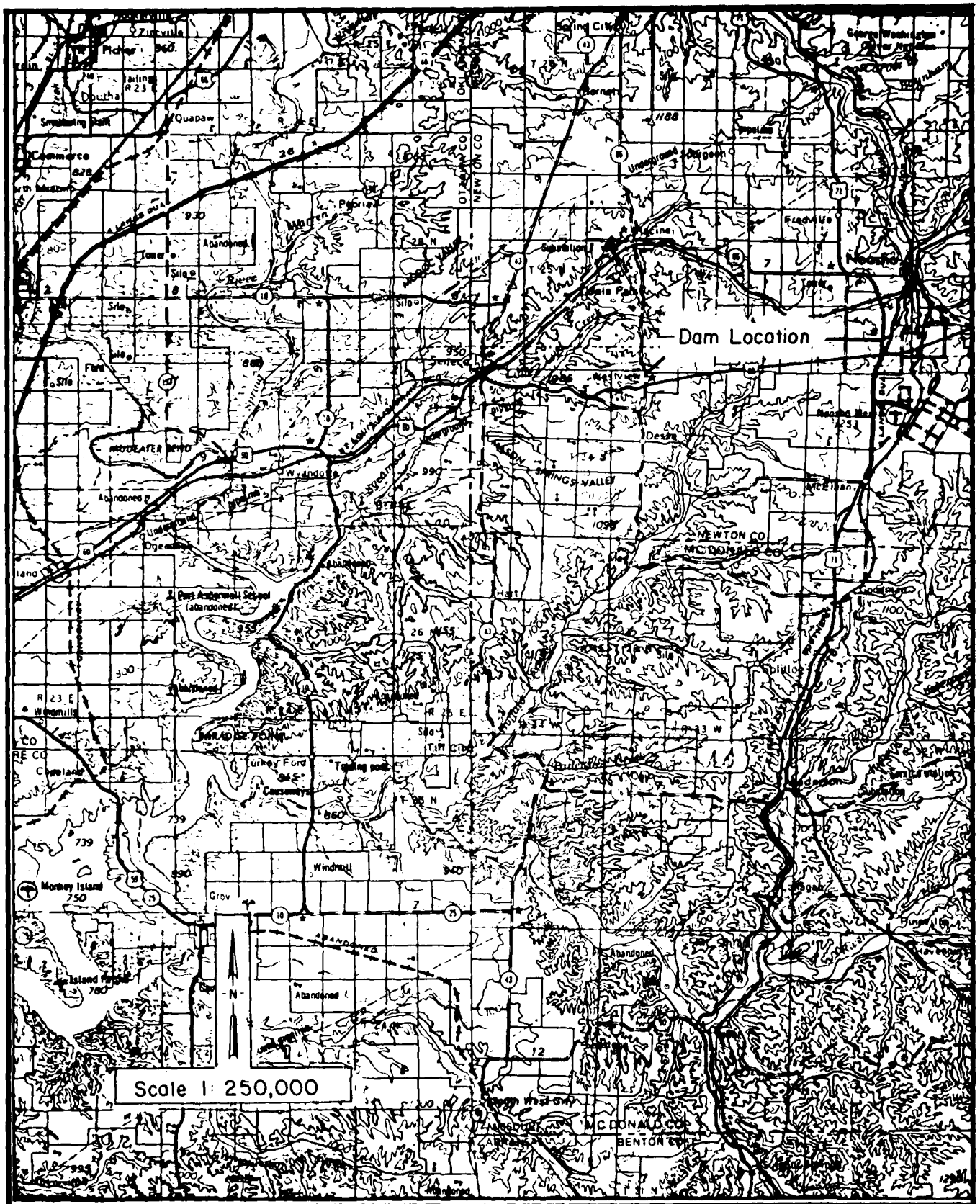
(6) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

Dam Location and Plans



LOCATION MAP



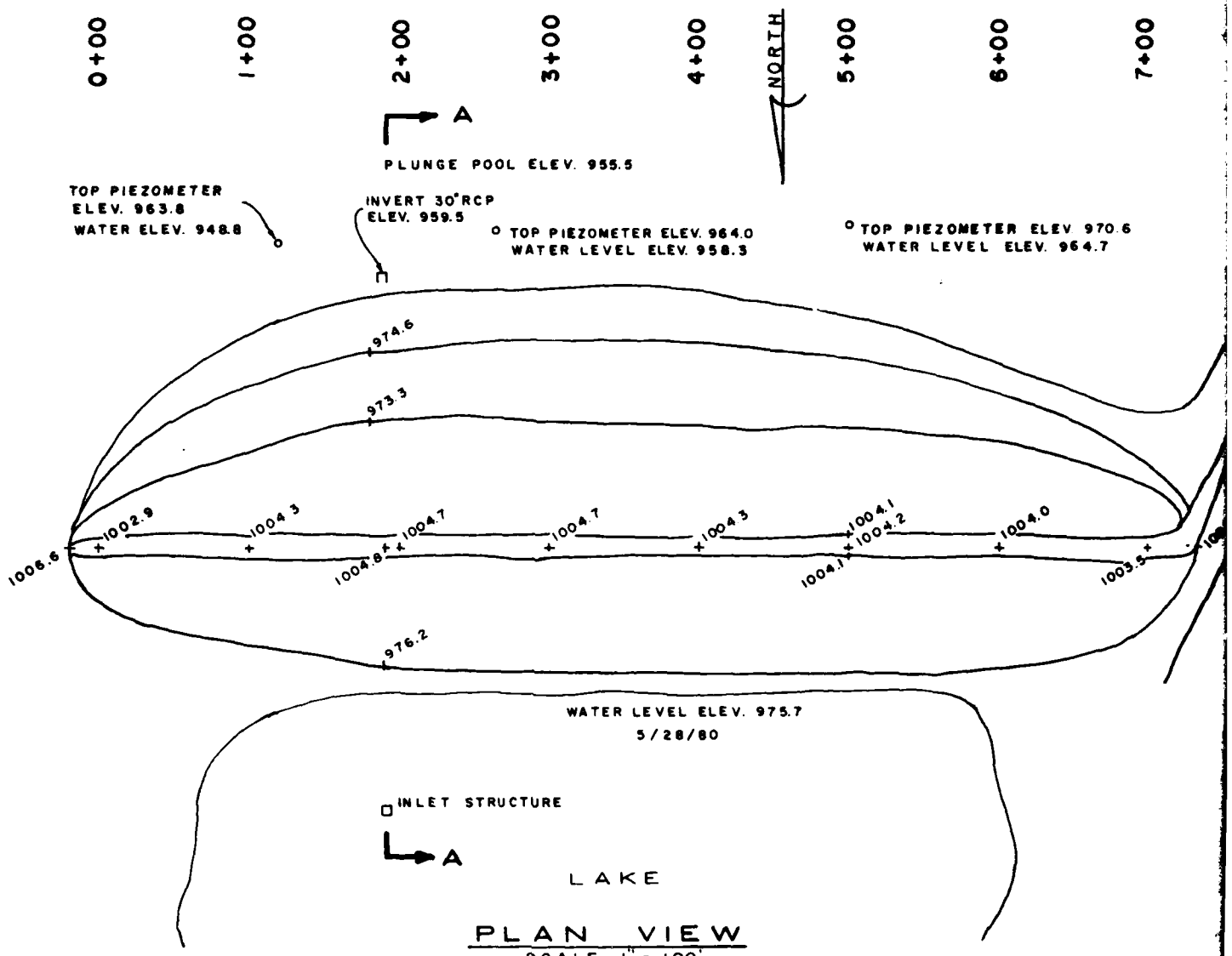
VICINITY MAP

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Newton County Structure E-1 Dam
Newton County, Missouri
Mo. I.D. No. 20511

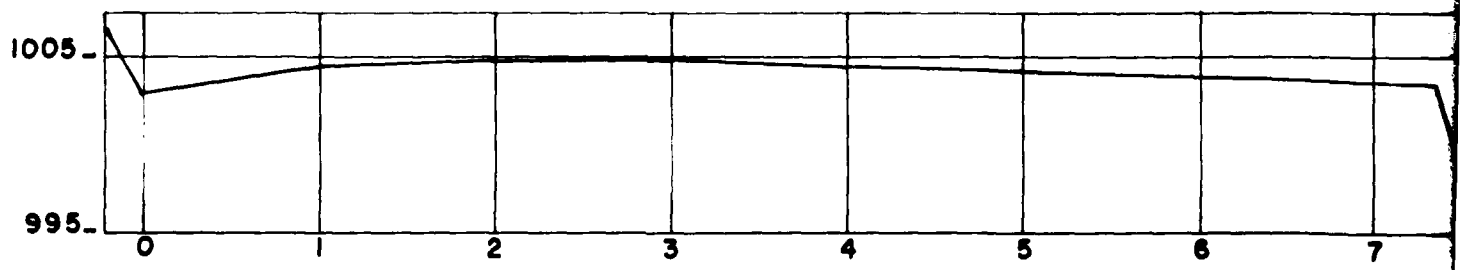
Sheet 2, Appendix A



PLAN VIEW

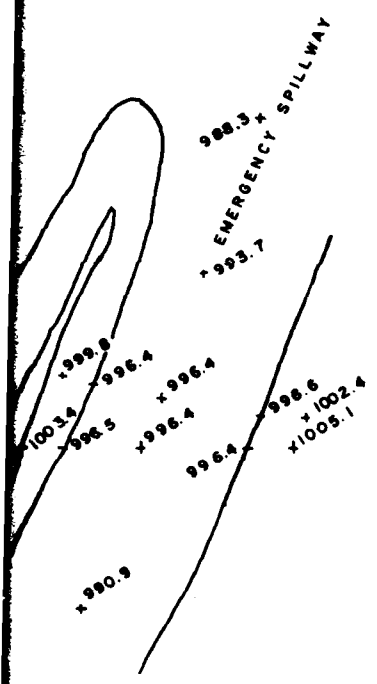
SCALE: 1" = 100'

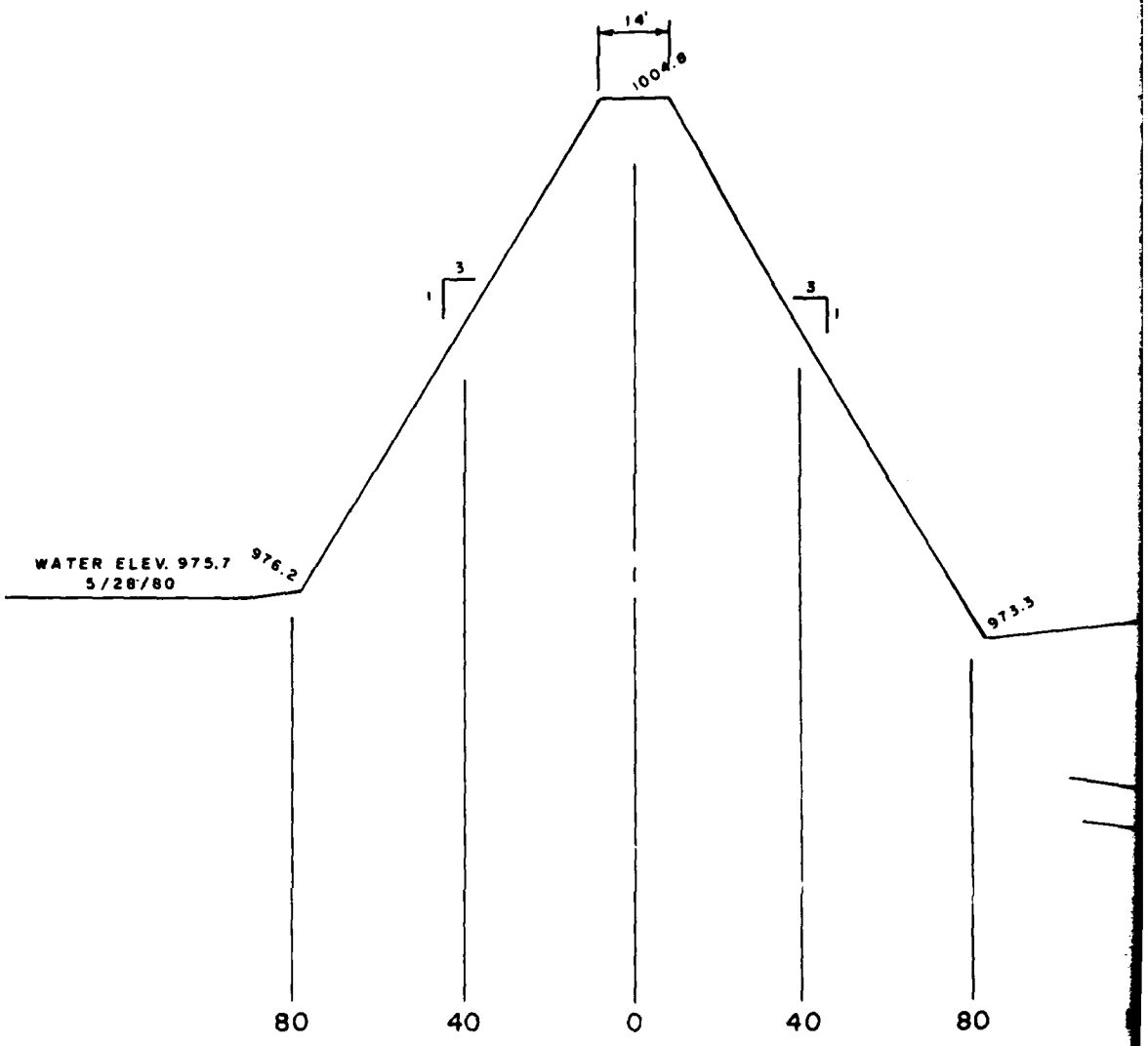
BENCHMARK: #1
CONCRETE MONUMENT 50' LEFT
OF STA 0+00 ℄ DAM
ELEV. = 1005.3



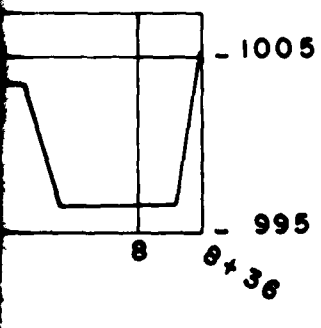
PROFILE

8+00

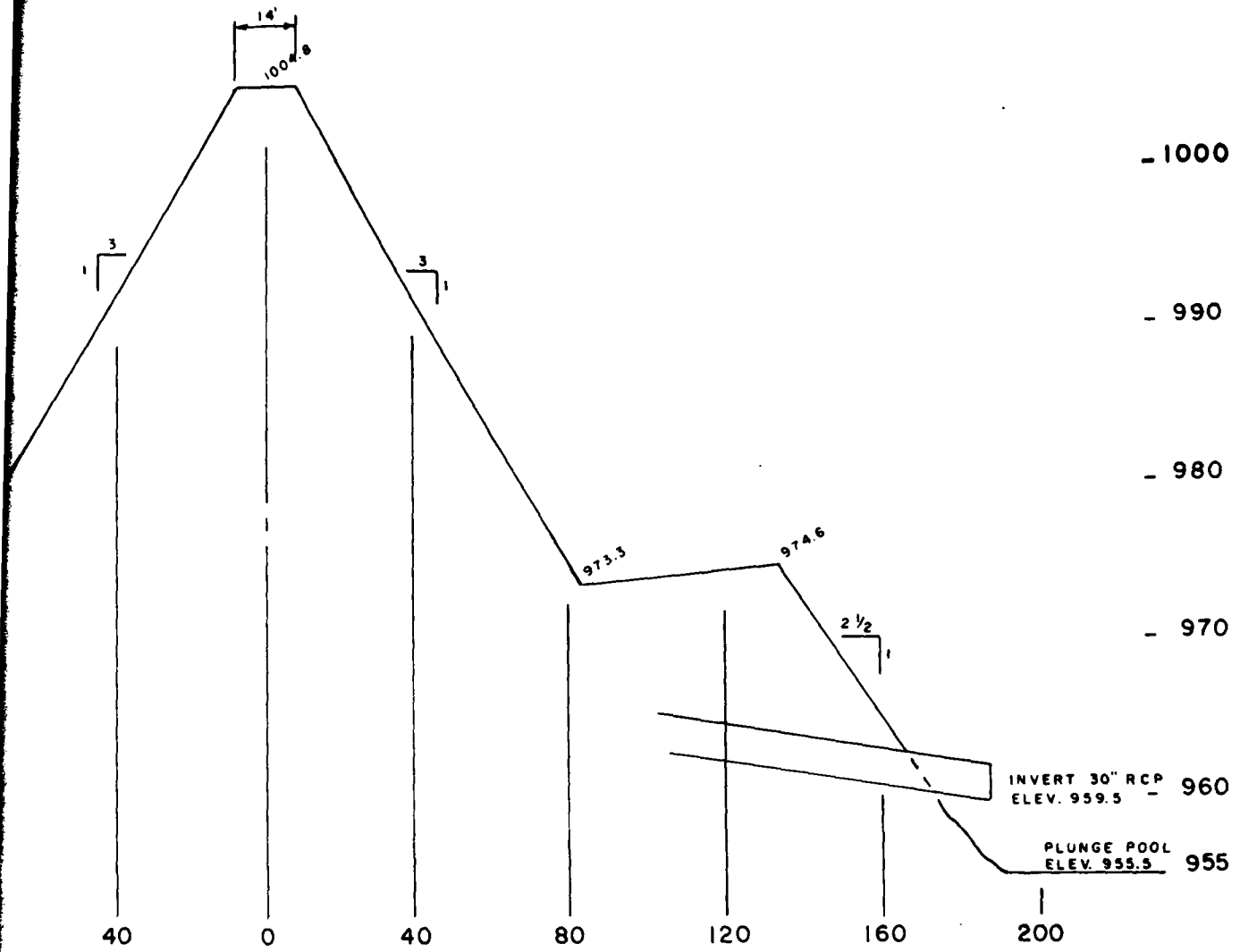




SECTION A-A STA 1+90



8+36



SECTION A-A STA 1+90

SHEET 3 APPENDIX A

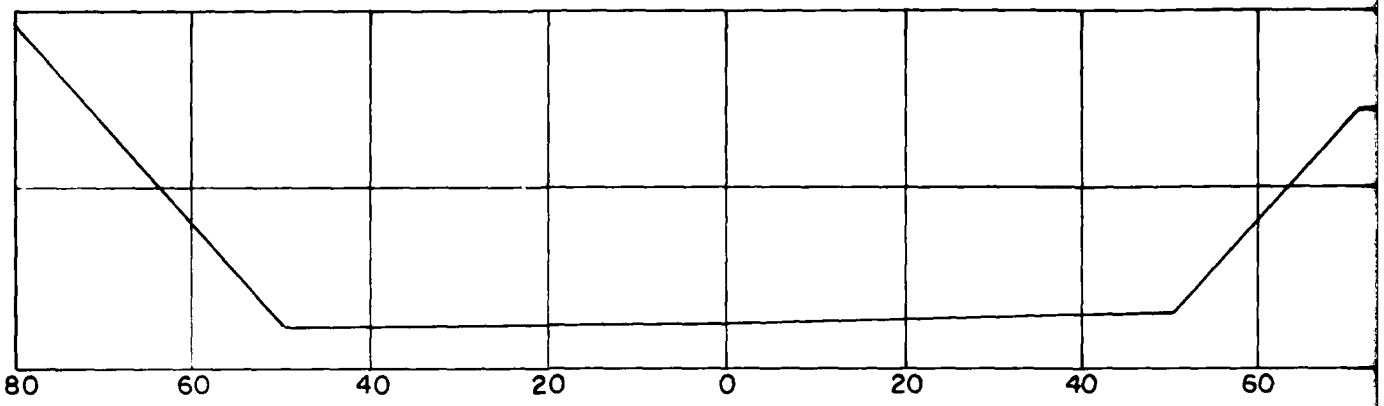
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

NEWTON COUNTY STRUCTURE E-1

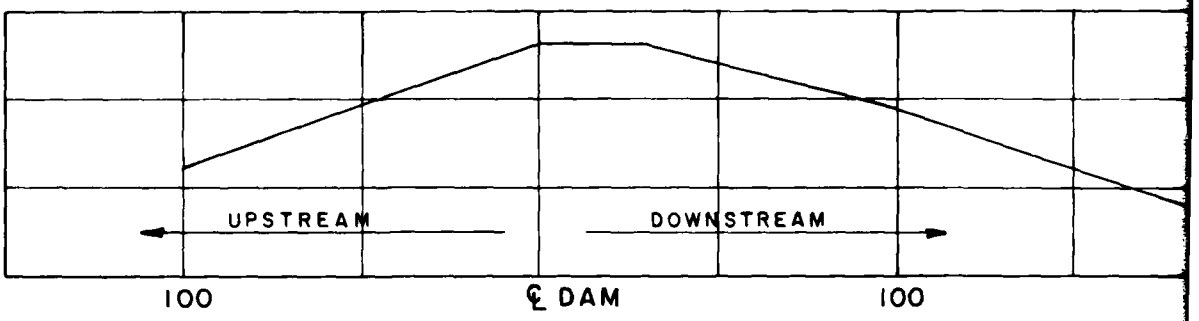
MO. No. 20511

PLAN & PROFILE

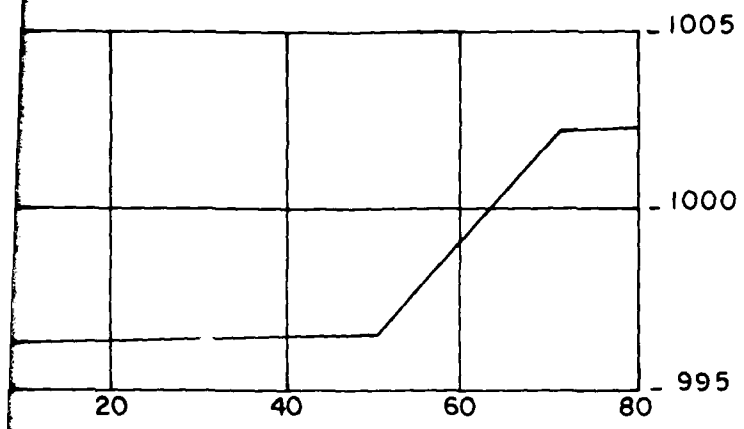
NEWTON COUNTY, MO.



SPILLWAY SECTION
25 FT. LEFT ℄ DAM

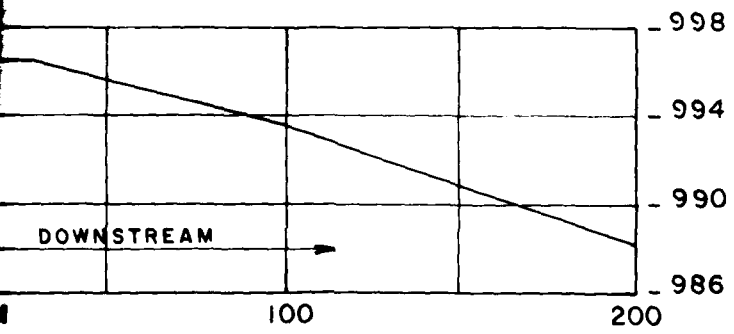


SPILLWAY PROFILE



ECTION

DAM



AY PROFILE

SHEET 3A APPENDIX A

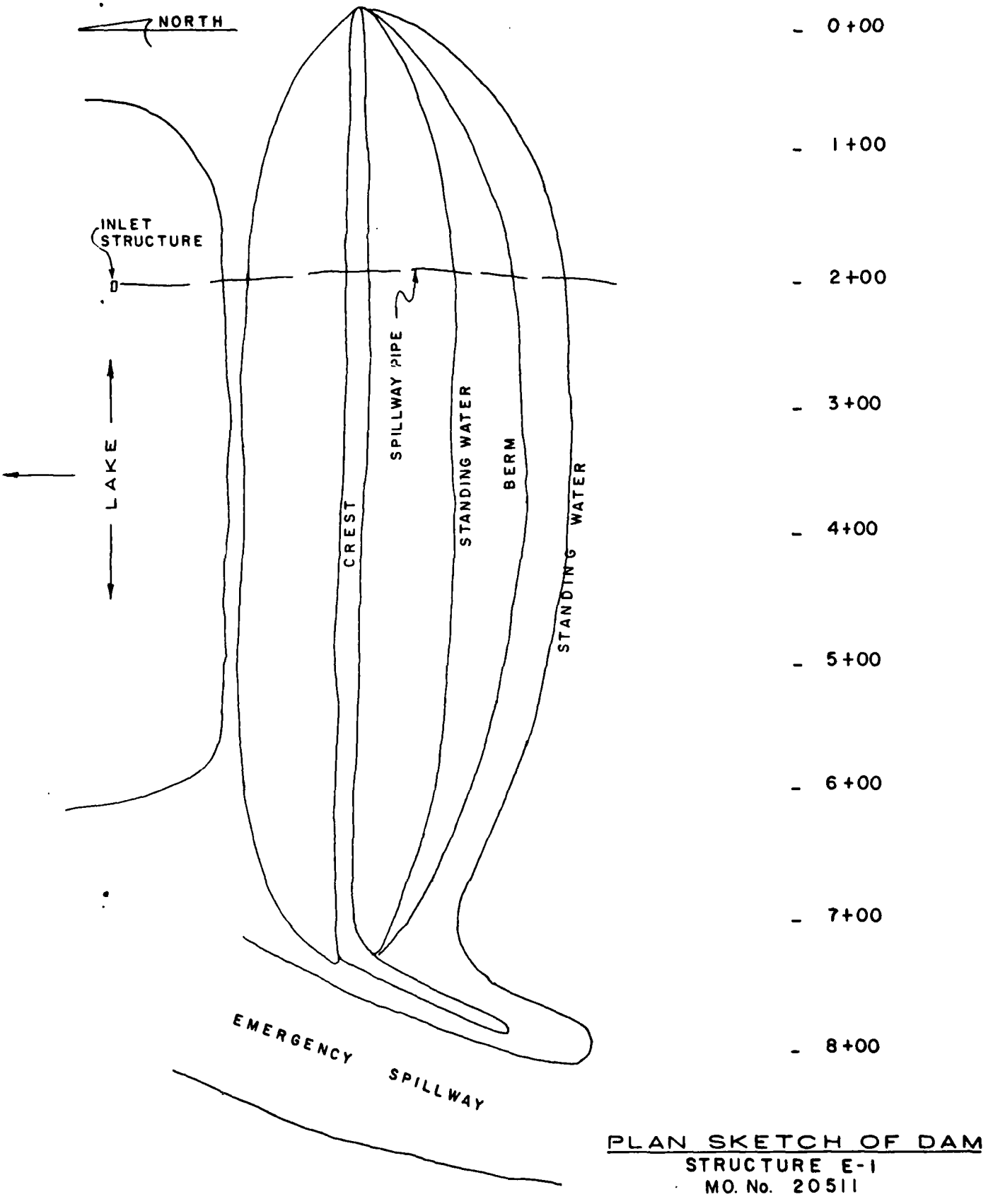
ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

NEWTON COUNTY STRUCTURE E-1

MO. No. 20511

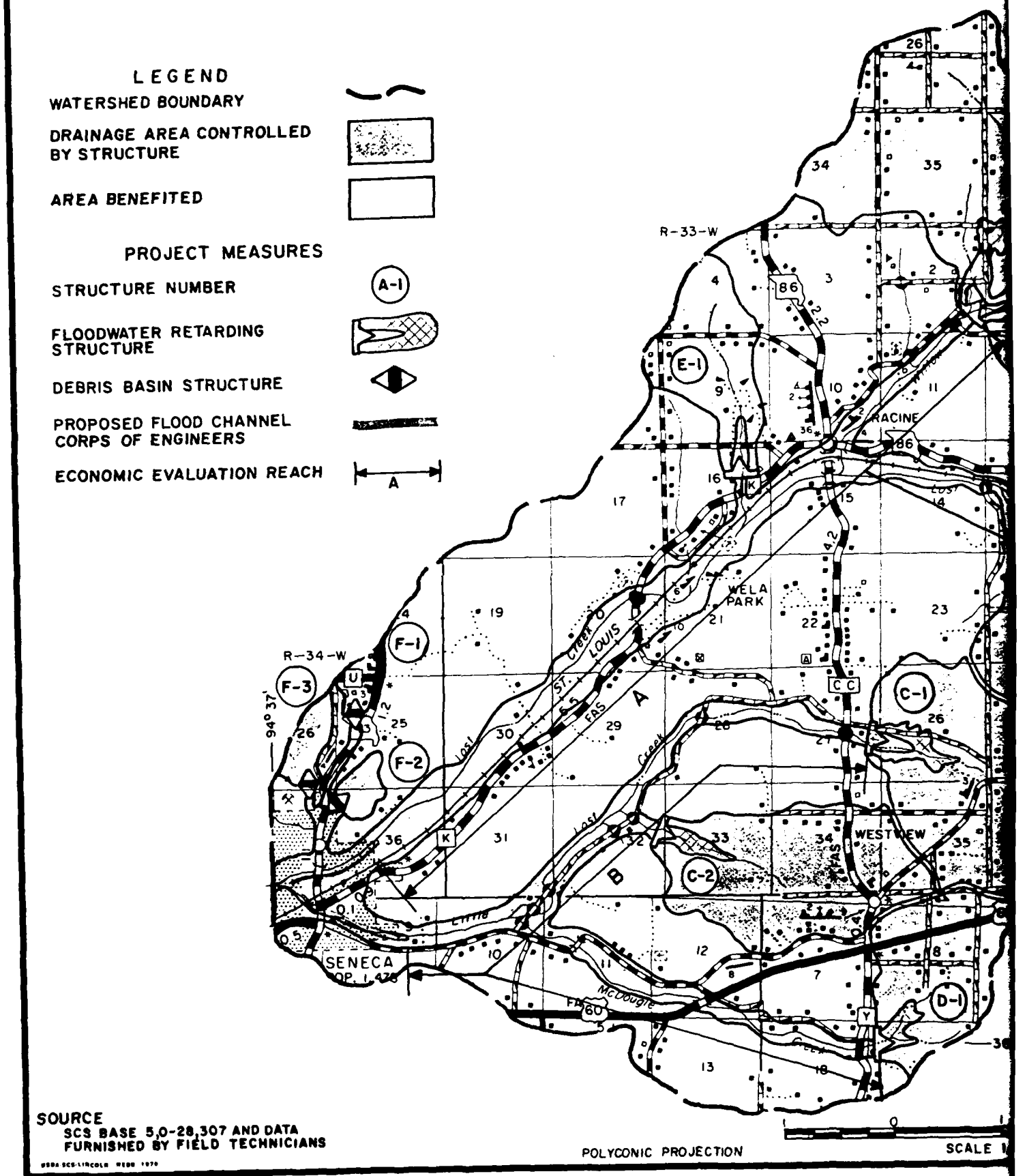
SPILLWAY
SECTION & PROFILE

NEWTON COUNTY, MO.

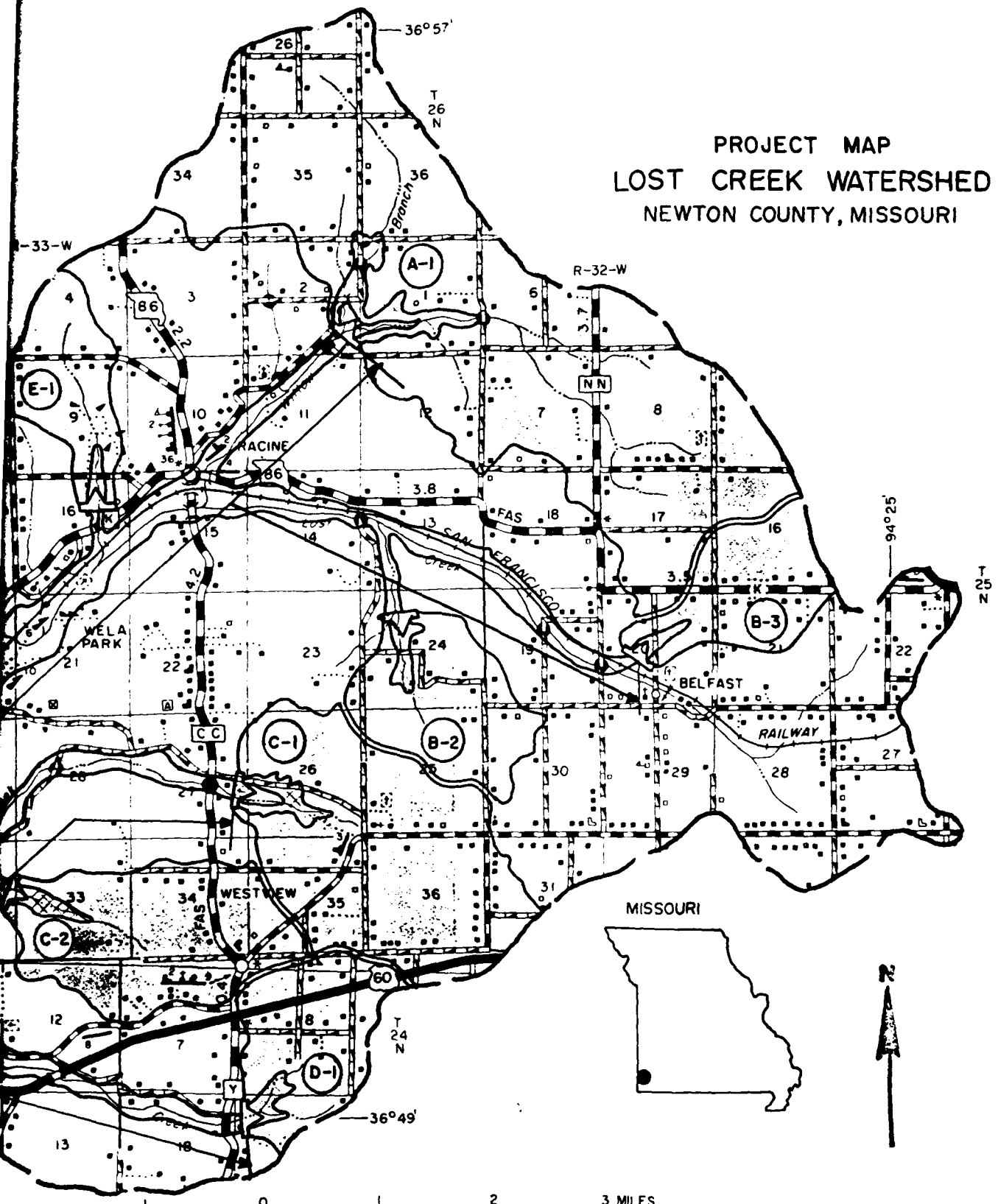


PLAN SKETCH OF DAM
STRUCTURE E-1
MO. No. 20511

U. S. DEPARTMENT OF AGRICULTURE



SOIL CONSERVATION SERVICE



DATA TABLE

Drainage Area, Acres	736
Sediment Storage, Acre Feet	60
Retarding Storage, Acre Feet	398
Sediment Pool, Acres	9.5
Retarding Pool, Acres	31.2

TBM #6 Elev. 959.18 Chiseled □ on corner of south headwall of culvert under Route "K", approx. 500' southeast of Buzzard's house.

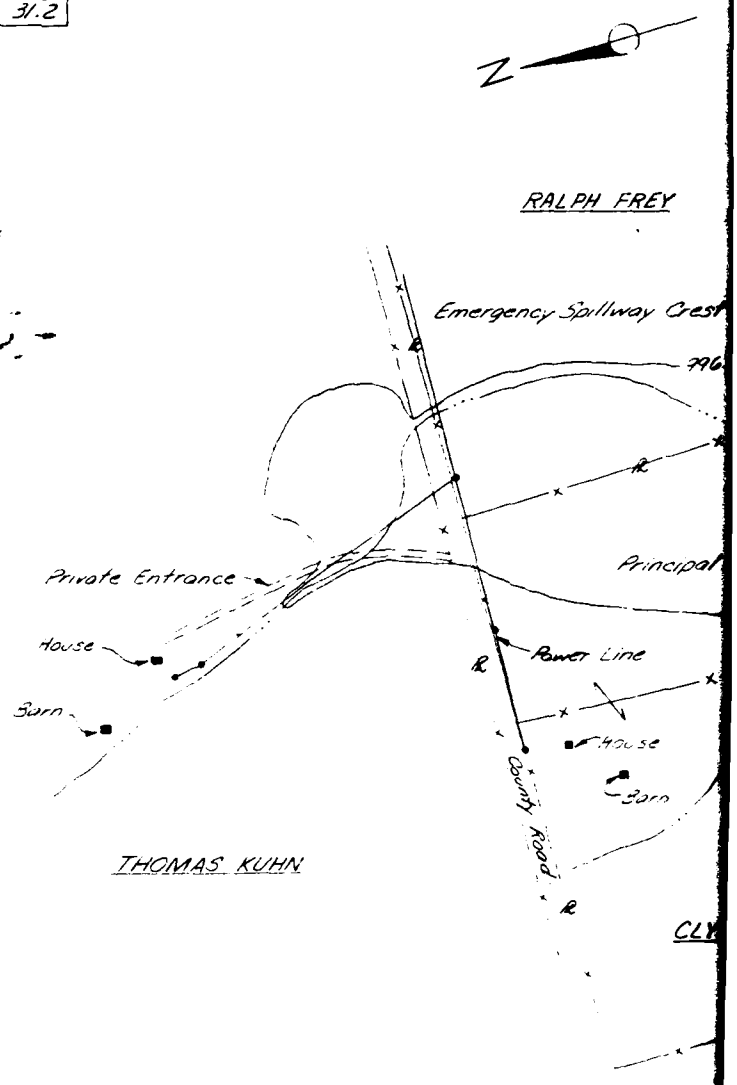
B.M. #1 Elev. 1005.30 Concrete Monument 50' Lt. of Sta 0+00 ℄ Dam.

Fl. #2 [illegible]

Structure S-1 is located approx ¾ mile west and ½ mile south of Racine, Missouri in the north ½ of Sec 16 and south ½ of Sec 9, T 25 N., R 3 W.

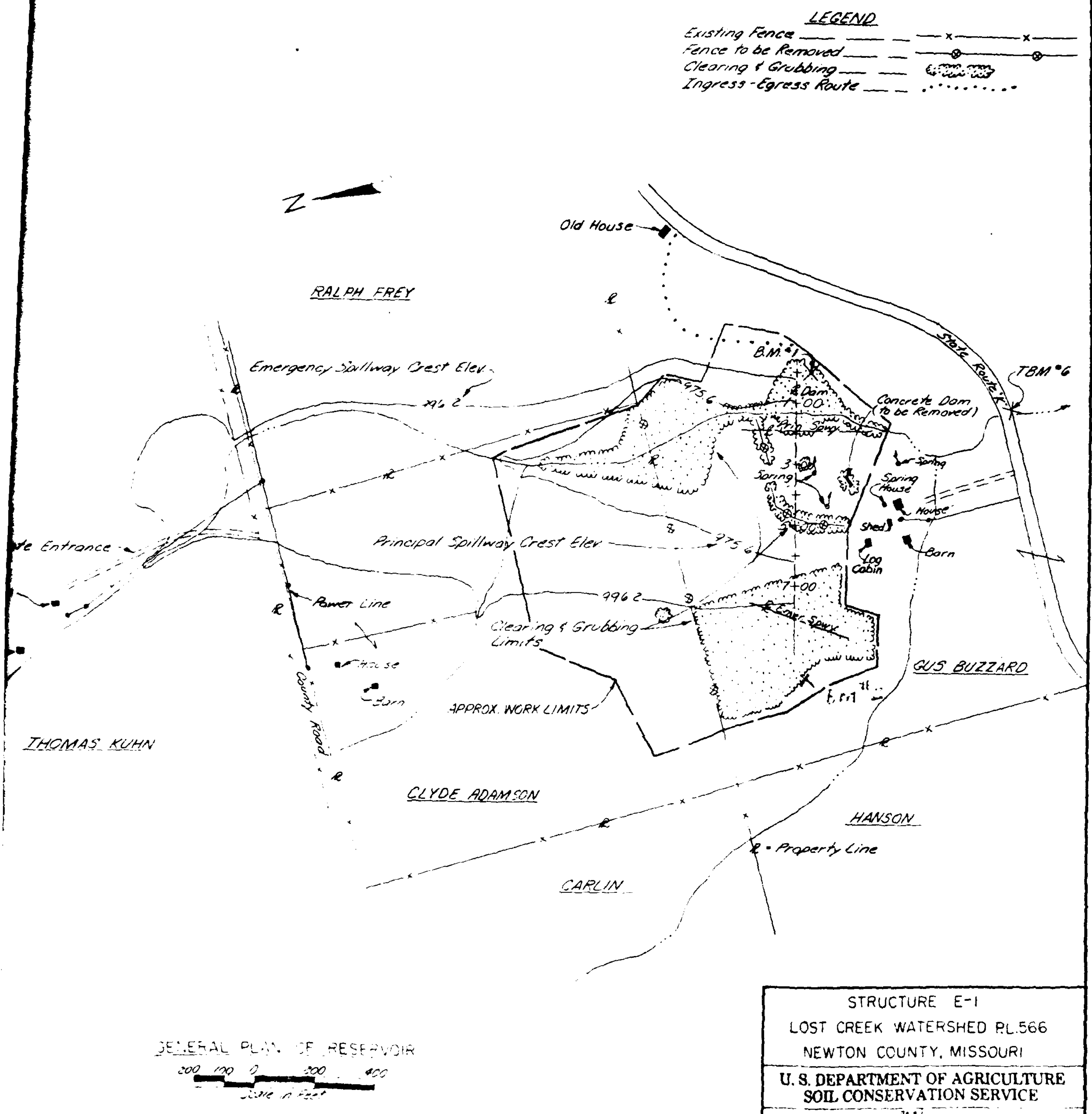
QUANTITIES

Clearing & Grubbing ..... Lump Sum
(Approx 8.9 Acres)



GENERAL PLAN OF RESERVOIR

200 100 0 200 400
Scale in Feet



STRUCTURE E-1
LOST CREEK WATERSHED P.L.566
NEWTON COUNTY, MISSOURI

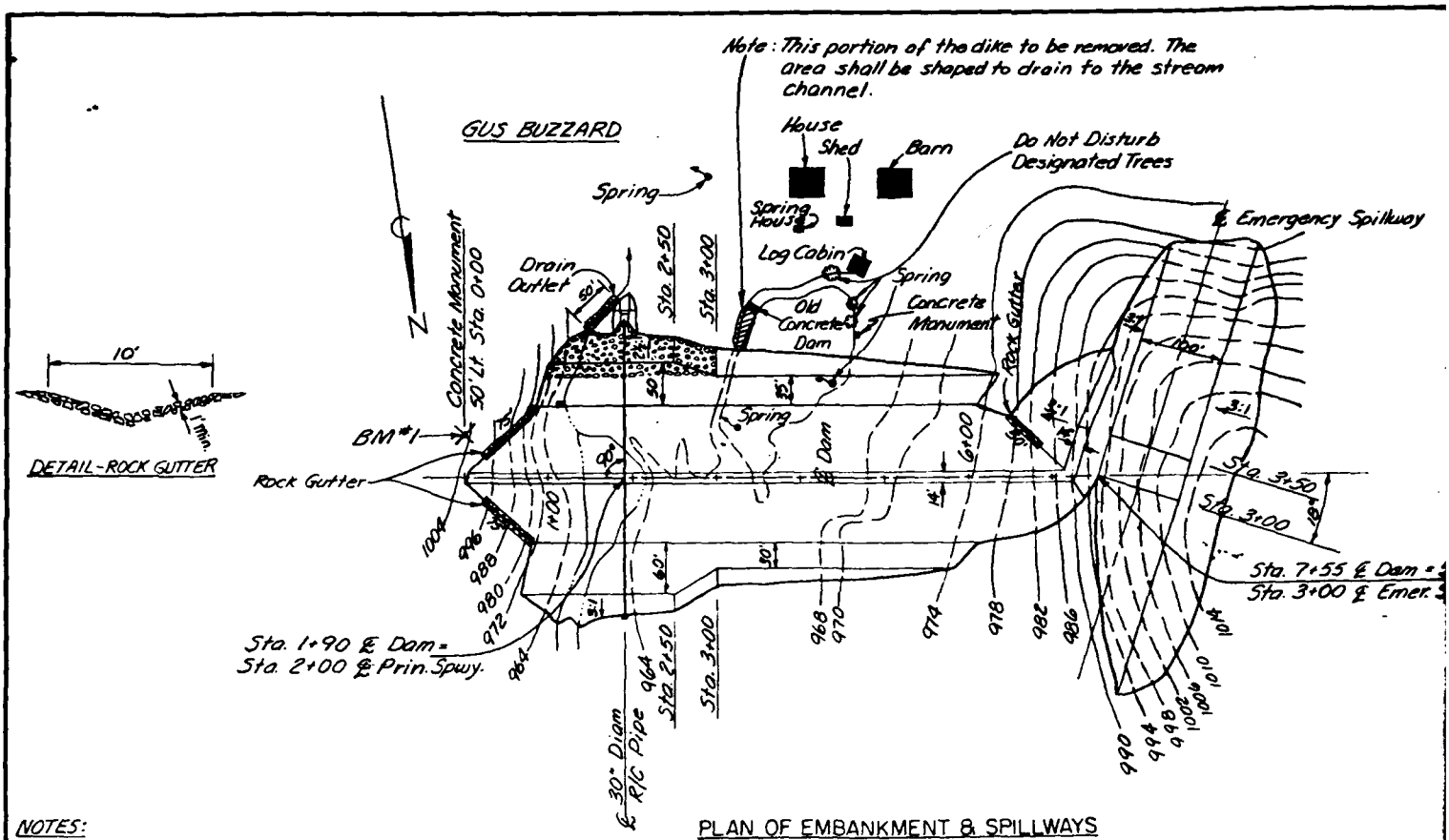
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed J A G	11-75	Approved by
Drawn C D J	11-75	
B A E	9-76	
M V R B R E S	9-7	2 / 17

5-E-32,913

Sheet 6 of Appendix A

2



PLAN OF EMBANKMENT & SPILLWAYS

100 50 0 100 200

Scale in Feet

NOTES:

Topsoil

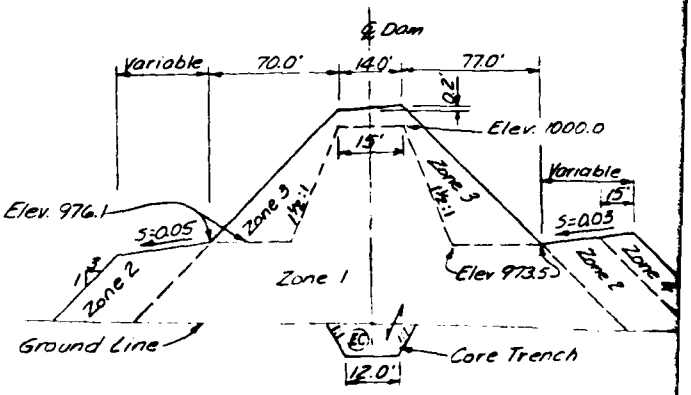
A minimum of six (6) inches of topsoil is to be placed on all compacted earth fill and in the earth portion of the emergency spillway.

Downstream Berm

The downstream berm has no longitudinal grade. Control elevations are shown on sheet 4.

Rock Gutters

Rock gutters shall be constructed with rock removed from the emergency spillway. The rock gutters are designated as rock fill



TYPICAL SECTION OF EMBANKMENT

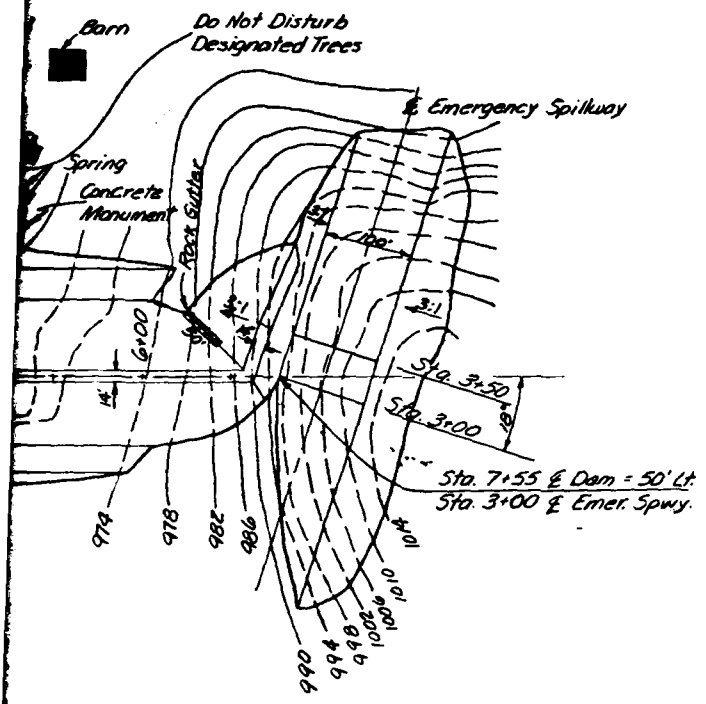
EMBANKMENT MATERIAL SOURCES AND PLACEMENT REQUIREMENTS

ZONE	SOURCE OF MATERIAL: LOCATION	APPROX DEPTH: From	APPROX DEPTH: To	UNIFIED SOIL CLASS.	PLACEMENT & MOISTURE DENSITY REQUIREMENTS: LIFT THICKNESS	MAX SIZE ROCK FRAG	COMP CLASS	COMP CONTROL	COMP REQ'D	ALLOWABLE MOISTURE
1	Borrow Area	5'	6'	CL or SC	9"	6"	A	ASTM D-698 Method C	95 %	Optimum or Slightly Above
1	Emer. Spwy.	4'	Grade of Rock	CH	9"	6"	A	ASTM D-698 Method A	95 %	Optimum or Slightly Above
2	Emer. Spwy.	0'	4'	GC, SP, SM	9"	6"	C	3 Passes	—	—
3	Pool Area	0'	3'	ML	9"	6"	A	ASTM D-698 Method A	95 %	Optimum or Less
4	Emer. Spwy. & Prin. Spwy.	3'	Grade of Rock		36"	18"	III	—	—	—

NOTES:

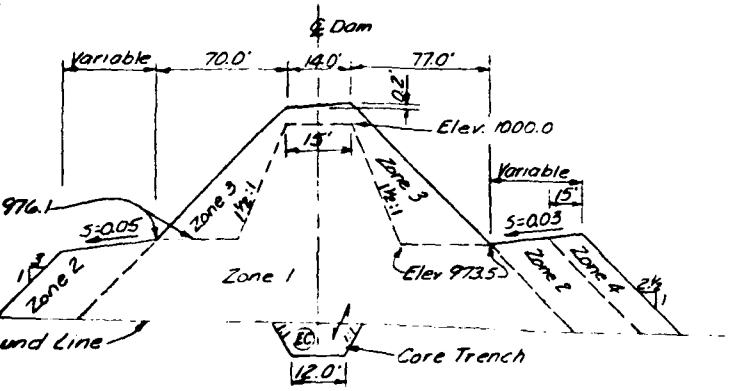
1. The borrow area will only be excavated to the top of the Pool area. The ML, CL and SC materials are the only m
2. The CH material shall be placed in the upstream portion
3. Class C fill shall be compacted by 3 passes of a stan minimum force of 200 p.s.i
4. If the SP, SM and GP materials are exhausted before material shall be used with Class A compaction to
5. Zone 4 fill is only required in the 50' wide portion
6. The hard rock or rock like material encountered in the

tion of the dike to be removed. The
ill be shaped to drain to the stream
y.



ANKMENT & SPILLWAYS

0 100 200
Scale in Feet



TYPICAL SECTION OF EMBANKMENT

QUANTITIES		
Excavation, Common (EC)		
Core Trench	2387	~~2,170~~ Cu Yds.
Structure	1070	~~1,000~~ Cu Yds.
Stream Channel	1304	~~1,230~~ Cu Yds.
Stilling Basin & Outlet Channel	123	~~100~~ Cu Yds.
Total	4884	~~4,500~~ Cu Yds.
Excavation, Rock (ER)		
Emergency Spillway	2497	~~1,600~~ Cu Yds.
Earth Fill		
Class (A)	99,959	~~100,500~~ Cu Yds.
Class (C)	13,584	~~13,400~~ Cu Yds.
Rock Fill	1568	~~1,420~~ Cu Yds.
Topsoil	5356	*~~6600~~ Sq Yds.
Seeding	14.2	~~15.0~~ Acres
Mulching	28.4	~~29.0~~ Tons
Temporary Seeding	0	~~6.0~~ Acres

5356 *~~6,600~~ Sq. Yds. topsoil at a depth of six (6) inches = ~~1,100~~ Cu. Yds.
893

NOTES:

1. The borrow area will only be excavated to the top of the CH material in the Sediment Pool area. The ML, CL and SC materials are the only materials to be borrowed.
2. The CH material shall be placed in the upstream portion of Zone 1 and below elevation 970.0.
3. Class C fill shall be compacted by 3 passes of a standard tamping roller exerting a minimum force of 200 p.s.i.
4. If the SM, GM and GP materials are exhausted before the Zone 2 is complete CL or SC material shall be used with Class A compaction to complete the up stream Zone 2.
5. Zone 4 fill is only required on the 50' wide portion of the downstream berm, Sta 1+00 ± Sta 3+00.
6. The hand compacted berm placed around the principal spillway shall be placed in 4 inch lifts.

STRUCTURE E-1
LOST CREEK WATERSHED P.L.566
NEWTON COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

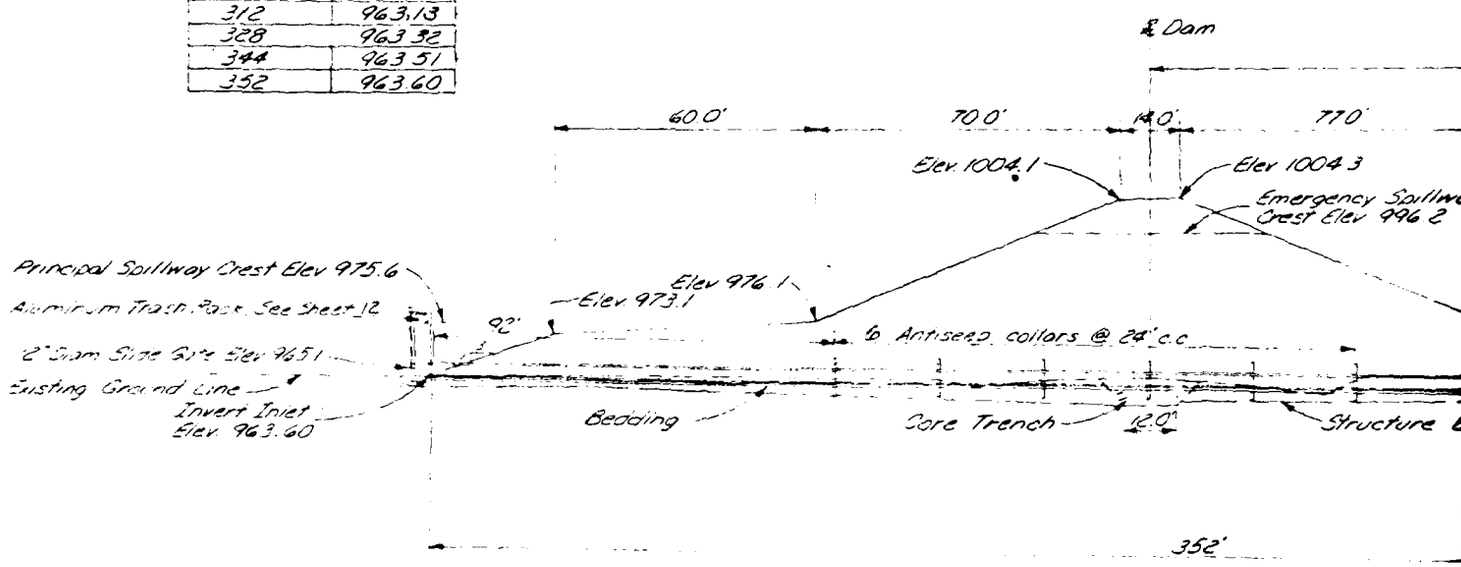
Designed M.M.B. & N.H.R. Traced Checked
Drawn B.E.S. Cross Section
Traced
Checked N.H.R. Sheet 7 of Appendix I

V

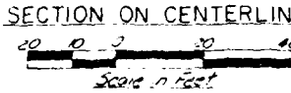
PIPE CAMBER TABLE	
Distance From Outlet	Elevation
0	959.50
16	959.69
24	959.78
40	959.97
56	960.15
72	960.34
88	960.63
104	960.90
120	961.16
136	961.39
152	961.63
168	961.85
184	962.04
200	962.22
216	962.39
232	962.53
248	962.68
264	962.81
280	962.93
296	963.04
312	963.13
328	963.32
344	963.51
352	963.60

NOTES:

1. Pipe elevations other than those shown will be furnished by the Engineer, when required.
2. Antiseep collars shall not be placed closer than (2) feet to a pipe joint.



SECTION ON CENTERLINE



MATERIALS

Concrete Class 4000

Steel Bar Reinforcement

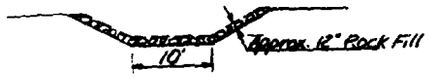
Prestressed Concrete Pressure Pipe 30" Diam, Steel Cylinder Type

Aluminum Trash Rack

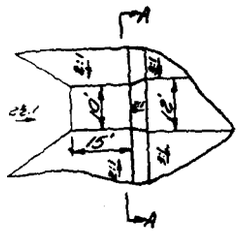
Slide Gate 12" Diam

NOTES:

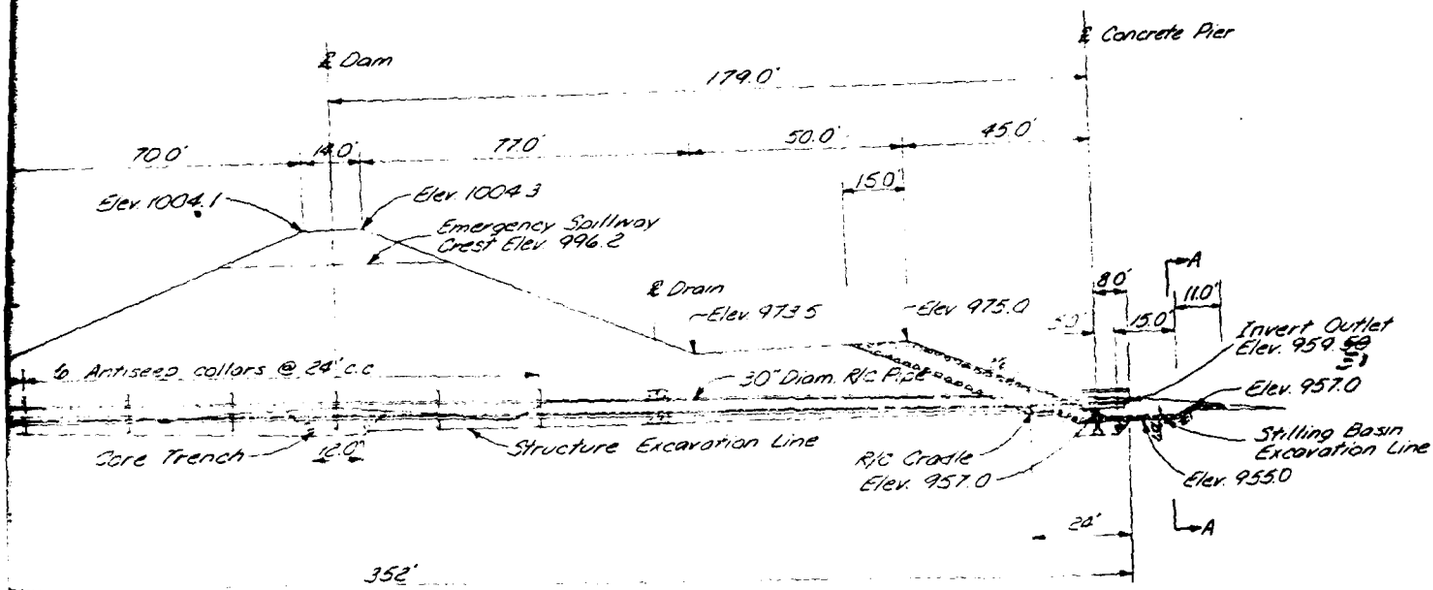
1. Pipe elevations other than those shown will be furnished by the Engineer, when required.
2. Antiseep collars shall not be placed closer than (2) feet to a pipe joint.



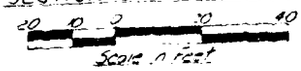
SECTION A-A



PARTIAL PLAN - OUTLET CHANNEL



SECTION ON CENTERLINE



MATERIALS

re Pipe 30" Diam, Steel Cylinder Type	58.2 Cu Yds
	3,489 Pounds
	352 Sq Ft
	Lump Sum
	1 Each

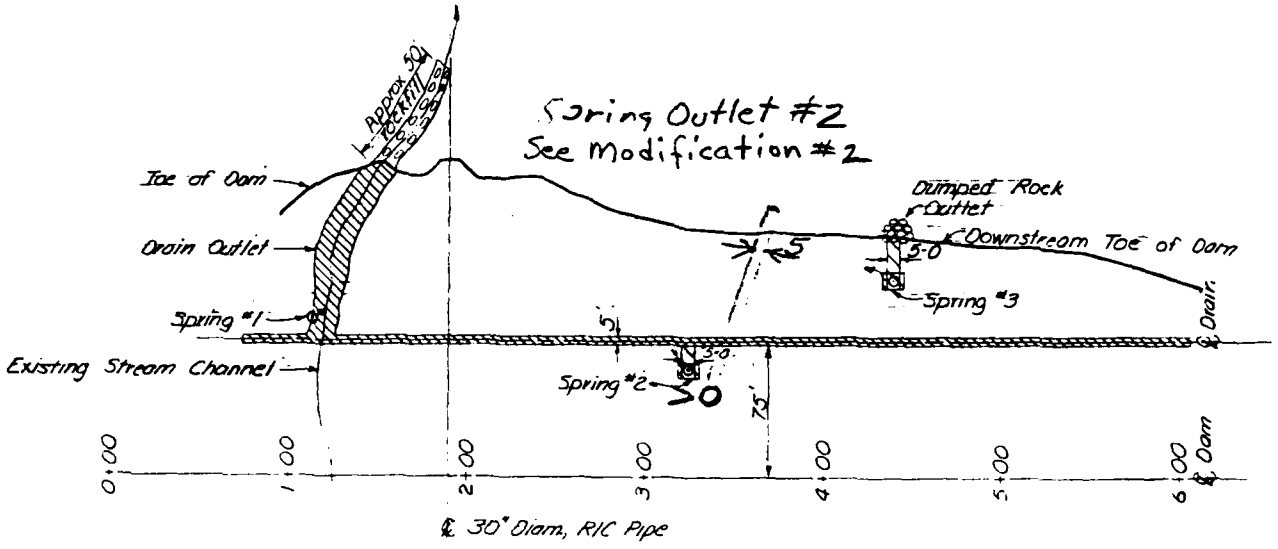
STRUCTURE E-1

R/C DROP INLET FOR 30" DIAM. PIPE
GENERAL LAYOUT
LOST CREEK WATERSHED P.L.566
NEWTON COUNTY, MISSOURI

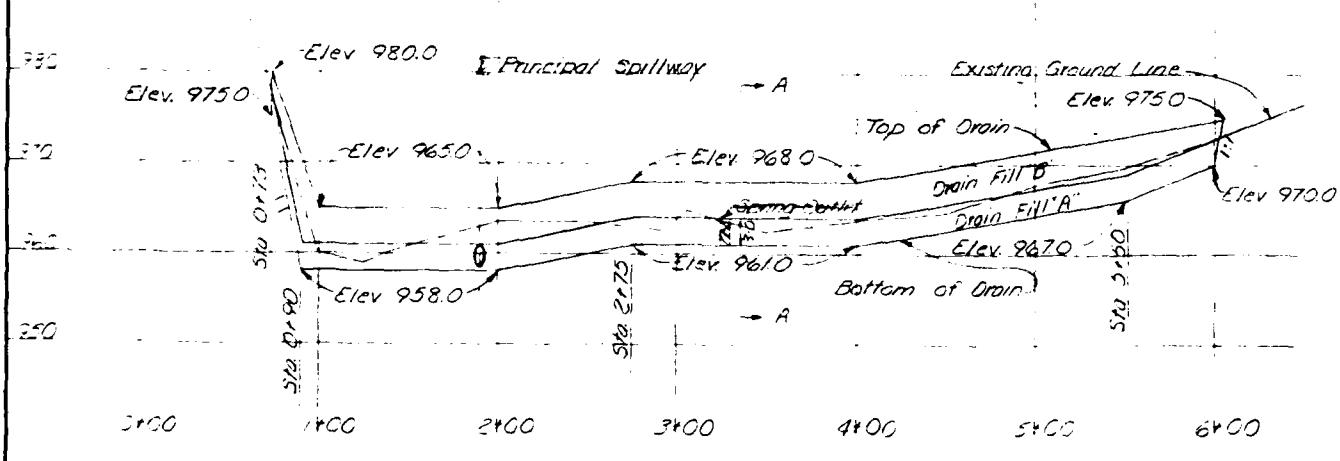
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W.M.H.
Drawn B.A.E.
Traced
Checked

Sheet 8 of Appendix A



PLAN



SECTION ON CENTERLINE OF DRAINAGE SYSTEM

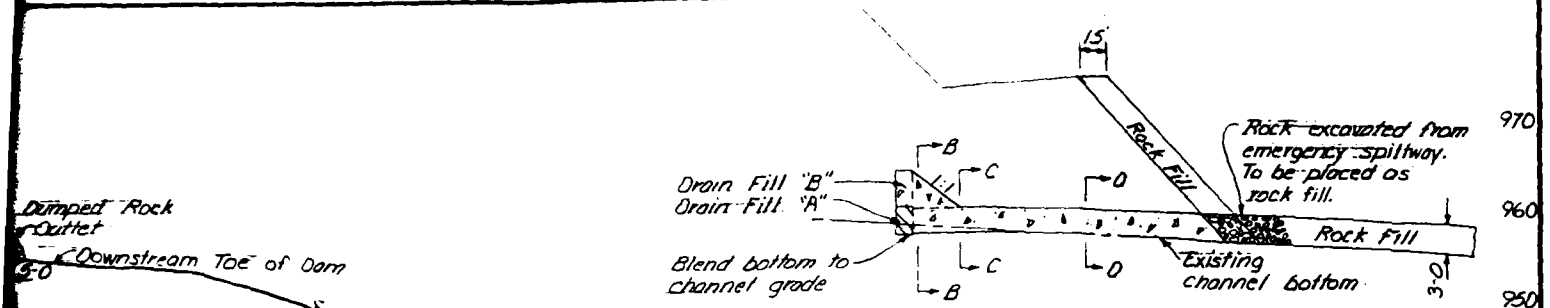
NOTES:

1. The outl... width u... channel ... conform ... depth o...
2. Drain F... gradatio... Si...
3. Drain F... gradatio... Si...
4. The spi... freely d... to stop... drain d... drain ... system... with ... with d... the dra... filled ... of rock... spillway... dam a...

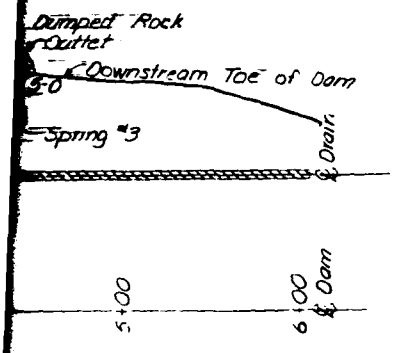
QUANTITIES 665

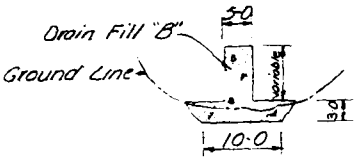
Drain Fill (Drain Fill 'A' = 295 cu.yd. Drain Fill 'B' = ~~395~~ cu.yd. Total ... 760 ~~860~~ Cu. Yds

Fill + For Outlet (to be excavated from emergency spillway and ... drain fill) ... 105 ~~75~~ Cu Yds.

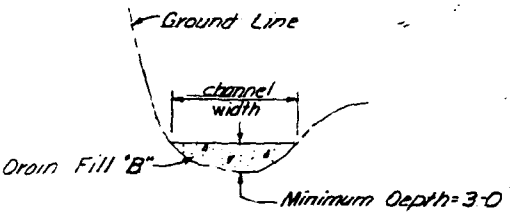


SECTION ON CENTERLINE OF DRAIN OUTLET

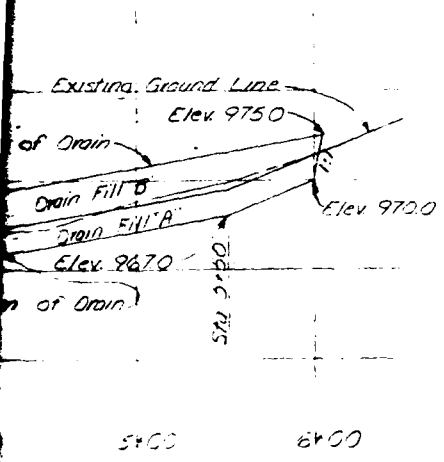




SECTION B-B



SECTION D-D



STEM

NOTES

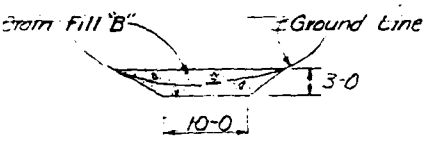
1. The outlet section shall have a 10' bottom width until the grade blends with the channel bottom. Then the outlet shall conform to the channel shape, have a depth of 3, and be as wide as the channel.
2. Drain Fill "A" shall conform to the following gradation:

Sieve Size	Percent Passing
3/8"	100
#4	95 - 100
#16	50 - 95
#50	10 - 30
#100	02 - 10

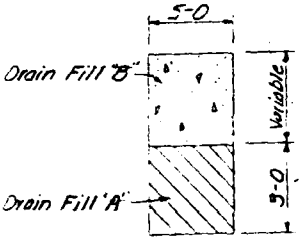
3. Drain Fill "B" shall conform to the following gradation:

Sieve Size	Percent Passing
1"	100
3/4"	85 ~~90~~ - 100
3/8"	20 - 55
#4	0 - 10
#8	0 - 5

4. The springs shall be cleaned out until they flow freely or until the Engineer directs the cleanout to stop. Spring #1 will outlet directly into the drain outlet. ~~Spring #2 will be backfilled with drain fill "B" and be connected to the drain system by a 5' wide and 3' deep trench filled with drain fill "B".~~ Spring #3 will be backfilled with drain fill "B" and outlet to the toe of the dam through a 5' wide and 3' deep trench filled with drain fill "B". Approximately 2 cu yd. of rock excavated from the emergency spillway shall be dumped on the toe of the dam as outlet protection for spring #3.



SECTION C-C



SECTION A-A

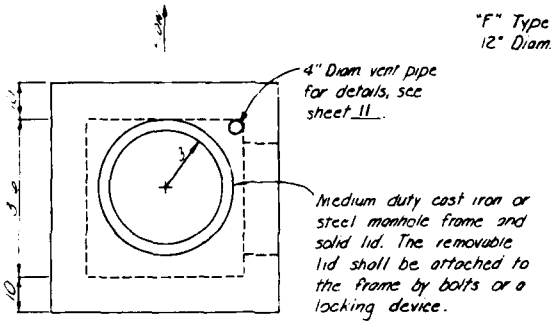
760 ~~800~~ Cu Yds
Fill 105 ~~110~~ Cu Yds

STRUCTURE E-1
DRAINAGE SYSTEM
LOST CREEK WATERSHED PL-566
NEWTON COUNTY, MISSOURI

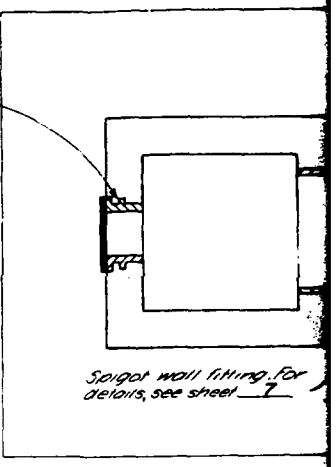
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Des. M. M. B
Drawn J. A. G
Traced
Chk. NHR

5 E 36 3 14

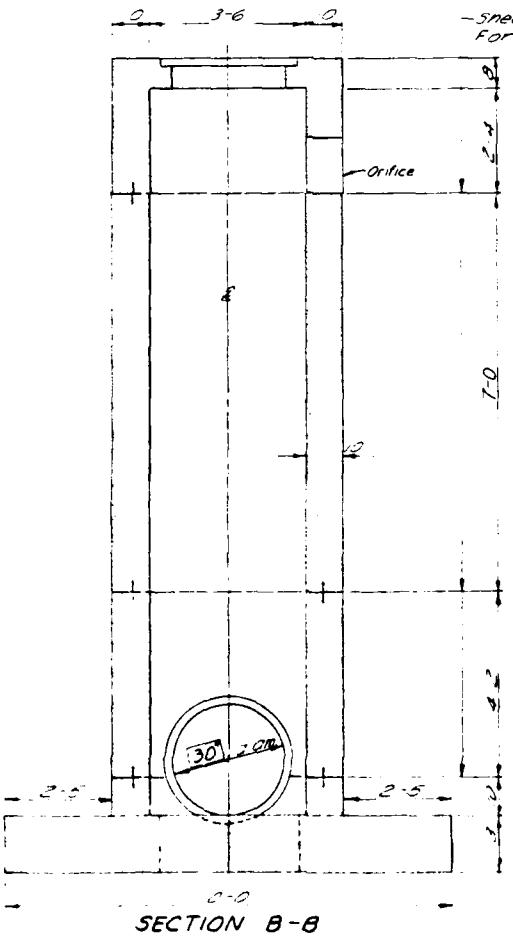


TOP PLAN

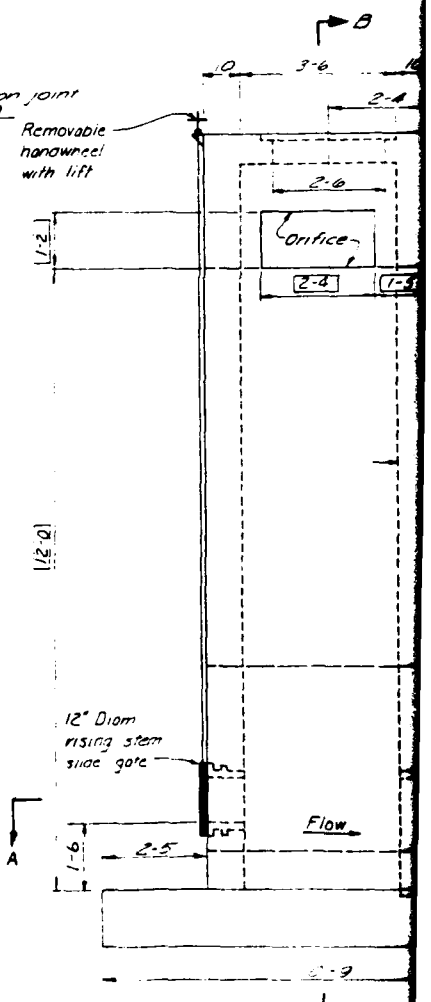


SECTION A-A

NOTES FOR DETAIL OF TRASH RACK AND ANCHORAGE SEE SHEET 12.



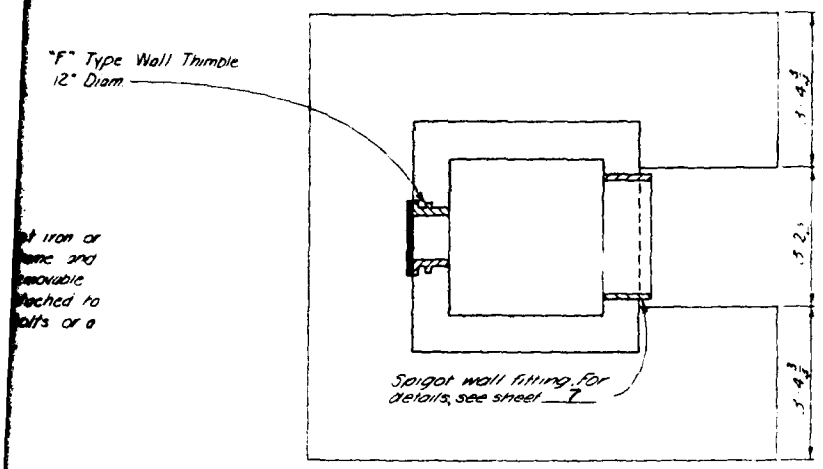
SECTION B-B



SIDEWALL ELEV

DETAILS OF 3'-6" x 3'-6" RESTRICTED FLOW RISER
(10' ≤ Height ≤ 15' X Sidewall Orifice)

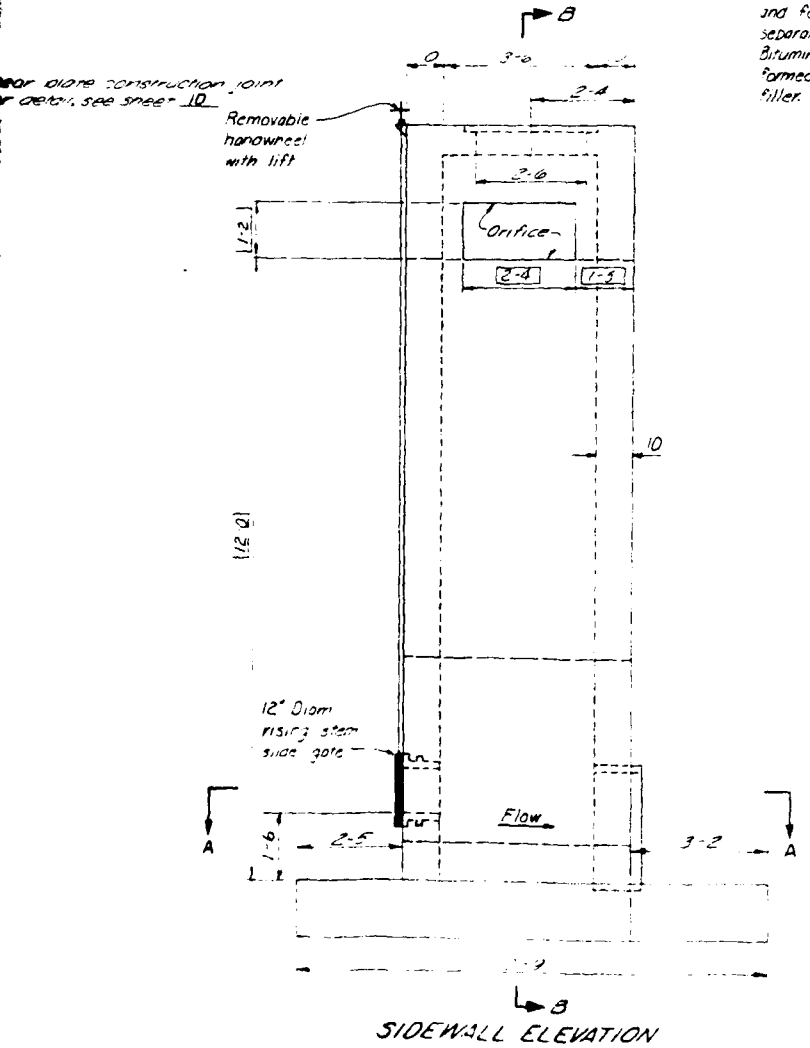
- 8 WP UNIT - DES - N SECTION	
LINCOLN, NEBRASKA	
RA - FWC NO. 5.E - 5.850.22	
DATE APPROVED MAY 10, 9[illegible]	
[illegible] 5.4	



SECTION A-A

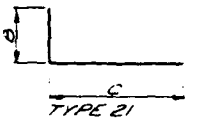
Note: Modify bedding shown on sheet 7 as required to fit between riser footing. Bedding and footing shall be separated by 3/4" Bituminous Type preformed expansion joint filler.

FOR DETAIL OF TRASH RACK AND ANCHORAGE SEE SHEET 12



SIDEWALL ELEVATION

BAR BENDS



STEEL SCHEDULE

MARK	SIZE	QUANTITY	LENGTH	TOTAL LENGTH	TYPE	B	C
B1	5	9	9-6	85-6	1		
B2	5	8	3-0	24-0	1		
B3	5	8	10-3	82-0	1		
B4	5	5	7-0	35-0	1		
B5	5	9	9-6	85-6	1		
B6	5	8	3-0	24-0	1		
B7	5	8	10-3	82-0	1		
B8	5	11	7-0	77-0	1		
B9	6	12	10-3	123-0	21	3-3	7-0
B10	5	6	7-9	46-6	21	0-9	7-0
B11	4	3	4-0	12-0	1		
B12	4	10	7-6	75-0	21	0-9	6-9
B13	4	6	7-6	45-0	21	0-9	6-9
B14	4	3	4-0	12-0	1		
B15	5	2	4-0	8-0	21	0-9	3-3
B16	5	18	6-6	117-0	21	3-3	3-3
B17	4	21	4-3	89-3	1		
B18	5	4	4-6	18-0	21	1-3	3-3
B19	5	1	2-9	2-9	21	0-9	2-0
B20	4	1	3-9	3-9	1		
B21	6	1	3-9	3-9	1		
B22	6	1	3-0	3-0	21	0-9	2-3
	6	35	8-3	288-9	1		
T2	6	7	6-9	47-3	1		
T3	5	42	6-6	273-0	21	3-3	3-3
T4	5	47	4-3	199-9	1		
T5	5	9	6-0	54-0	21	2-9	3-3
T6	5	2	3-6	7-0	21	0-9	2-9
T7	5	3	4-0	12-0	21	1-3	2-9
T8	5	1	3-9	3-9	21	1-0	2-9
T9	5	3	3-3	9-9	21	0-6	2-9
T10	5	1	2-6	2-6	21	1-3	1-3
T11	5	2	2-0	4-0	21	0-9	1-3
T12	5	1	4-6	4-6	21	1-3	3-3
T13	4	9	2-3	9-0	1		
T14	4	15	2-3	41-3	1		
T15	4	6	1-3	7-6	1		
T16	4	6	4-3	25-6	21	1-0	3-3
T17	4	10	3-9	37-6			
T18	4	3	1-0	3-0			
T19	4	3	3-6	10-6			

2 0 2 3 4
Scale in feet

QUANTITIES

STEEL

#4 BARS	668.25 ft	446.4	lb.
#5 BAR	210 ft	265	lb.
#6 BARS	76.25 ft	71.7	lb.
TOTAL		783.1	lb.

CONCRETE 4.2 = 30.12

STRUCTURE E-1

R/C RESTRICTED FLOW RISER
FOR 30" DIAM. R/C PIPE
LOST CREEK WATERSHED PL-566
NEWTON COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	M M B	8-76	
Drawn	J A G	9-76	
Traced			
Checked	B E S	9-76	5.E-36.316

STRUCTURE DATA

Class of Structure "C" Floodwater Retarding

Drainage Area (total) 736 Ac. 1.15 Sq.Mi.

(uncontrolled) 736 Ac. 1.15 Sq.Mi.

Time of Concentration 0.8 Hours

Soil Cover Complex Number 71 For A.M.C. II

Sediment Capacity Available 57.5 Ac.Ft. below Elev. 975.6

Total Sediment Capacity Available 60.0 Ac.Ft.

Capacity Equivalents (Vol.) 0.98 In.

Retarding Capacity Provided 398.0 Ac.Ft.

Capacity Equivalents (Vol.) 6.49 In.

Water Supply Provided None Ac.Ft.-Identify Uses

Principal Spillway:

Maximum Capacity ~~(low stage)~~ 59 c.f.s.

Maximum Capacity (high stage) — c.f.s.

10 Day Drawdown Elev. 975.6

Emergency Spillway:

Percent Chance Use 1 Storm Duration 6 Hour

Type Vegetated Earth "n" Value Used 0.04

Emergency Spillway Hydrograph for Class "C" Structures

Rainfall 12.00 in.

Runoff 8.19 in.

Peak Inflow 3,174 c.f.s.

Maximum Discharge - Emergency Spillway 442 c.f.s.

Maximum Water Surface Elev. 997.8

Velocity of Flow (Ve) 7.1 f.p.s.

Supplementary Data and Special Design Features:

Principal Spillway Crest Elev. = 975.6

Emergency Spillway Crest Elev. = 996.2

Emergency Spillway Bottom Width = 100'

Settled Top of Dam Elev. = 1003.2

Height x Storage = 37.2 x 458 = 17,038

Freeboard Hyd

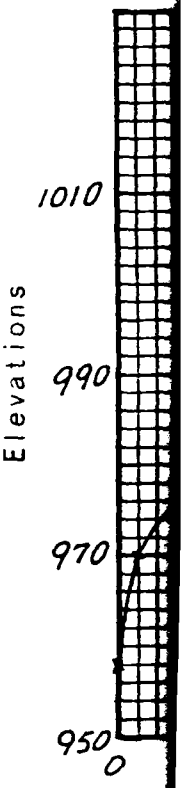
Rainfall

Runoff

Peak Infl

Maximum D

Maximum W



Supplementar
Special Desi

STRUCTURE DATA

Freeboard Hydrograph for Class "C" Structures

Rainfall 28.80 in.

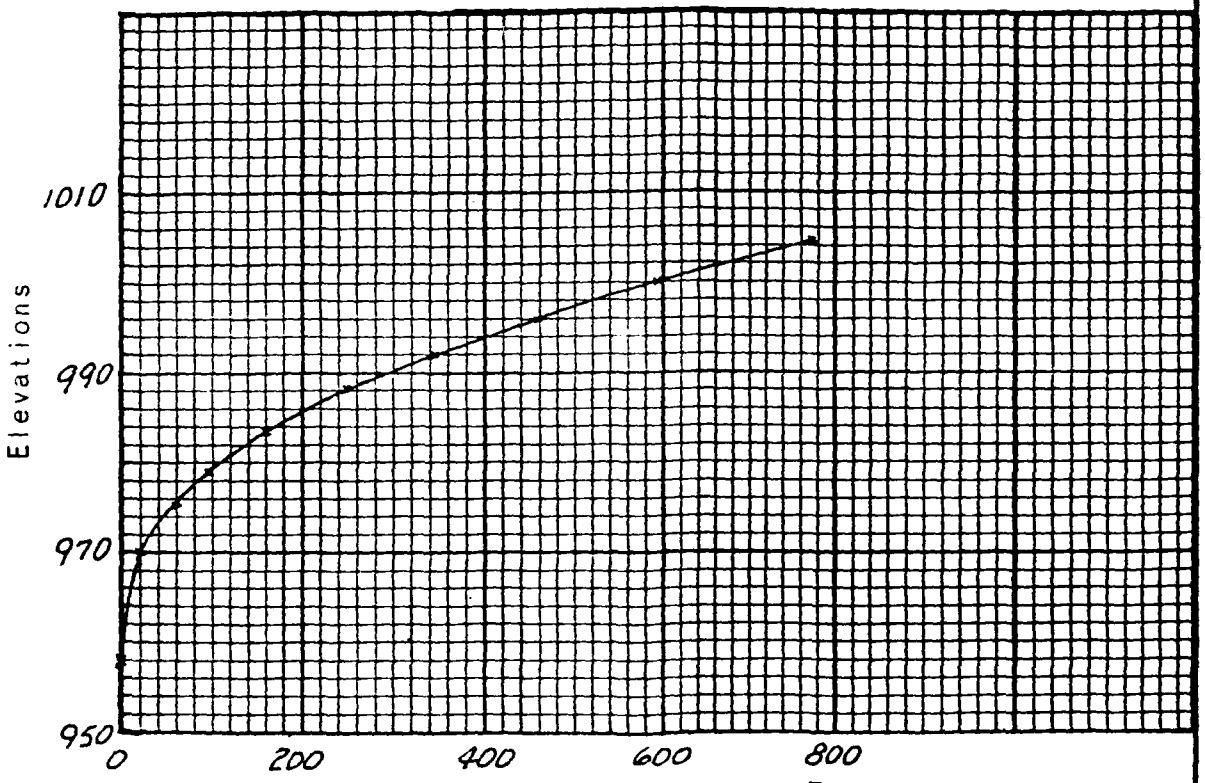
Runoff 24.41 in.

Peak Inflow 9,719 c.f.s.

Maximum Discharge - Emergency Spillway 5,715 c.f.s.

Maximum Water Surface Elev. 1003.0

Reservoir Capacity



Total Storage - Ac.Ft.

AS BUILT
8-3-79

Supplementary Data and Special Design Features:

STRUCTURE E-1
LOST CREEK WATERSHED PL-566
NEWTON COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed J.A.G.	Date 11-75	Approved by	
Drawn B.E.S.	11-76	Title	
Traced		Title	
Checked M.M.B. E.N.H.R. 12-76	Sheet No. 1 of 1	Drawing No. 5,E-36,314-H	

Sheet 11 of

Base Drawing 5,E-13,850.20

1-AS-33a (11/70) UNITED STATES DEPARTMENT OF AGRICULTURE
Refer to AMS-210-5 SOIL CONSERVATION SERVICE
File Code: AS-12-13 Columbia, Missouri 65201

OPERATION AND MAINTENANCE INSPECTION REPORT FOR STRUCTURES

May 14, 1980

Watershed Lost Creek Structure No. E-1 Inspection: Special [ ] Annual [x]
Newton County

Item	Condition Satisfactory	Condition Unsatisfactory	Describe Maintenance and Needed Repairs	Estimated Costs	Agreed Date Repairs To Be Compl'd	Date Repairs Compl'd
Vegetation		✓	Topdress where needed with 20-20-10	$20	9-15-80	
Fences	NA					
Principal Spillway	✓					
Emergency Spillway		✓	Fill rills with topsoil, mulch and seed	$100.00	9-15-80	
Embankment	✓					
Reservoir Area	✓					
Scour Hole & Outlet Chnl	✓					
Foundation Drains & Relief Wells		✓			9-15-80	
Other Downstream Channel		✓		$50	9-15-80	
Remarks:						
Temporary Diversions		✓		$200	9-15-80	

Warren N Bunge
District Conservationist

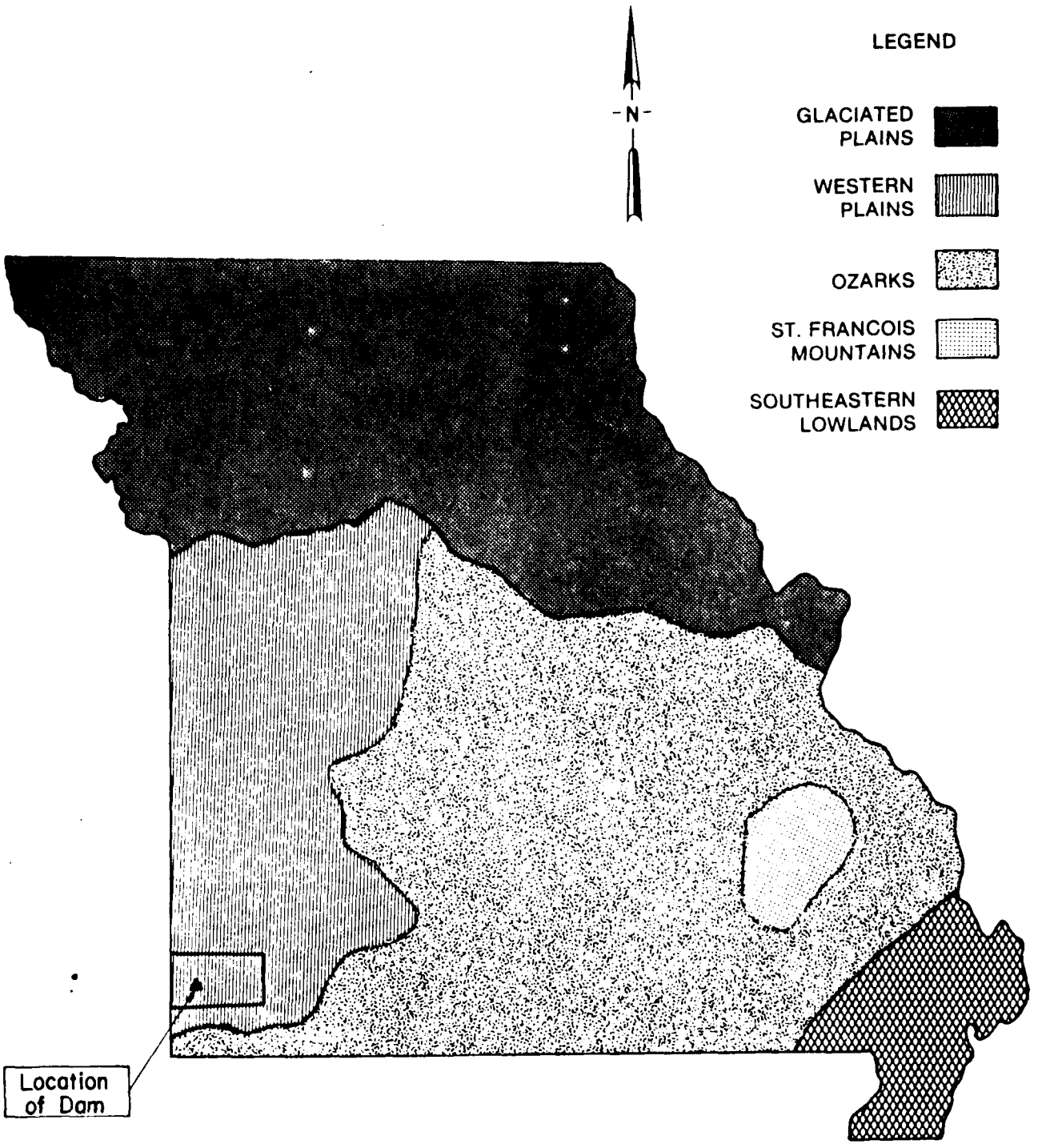
Sponsoring Local Organization Rep.

Newton Soil and Water Conservation District
Sponsoring Local Organization

(Check list on reverse side)

APPENDIX B

Geology and Soils



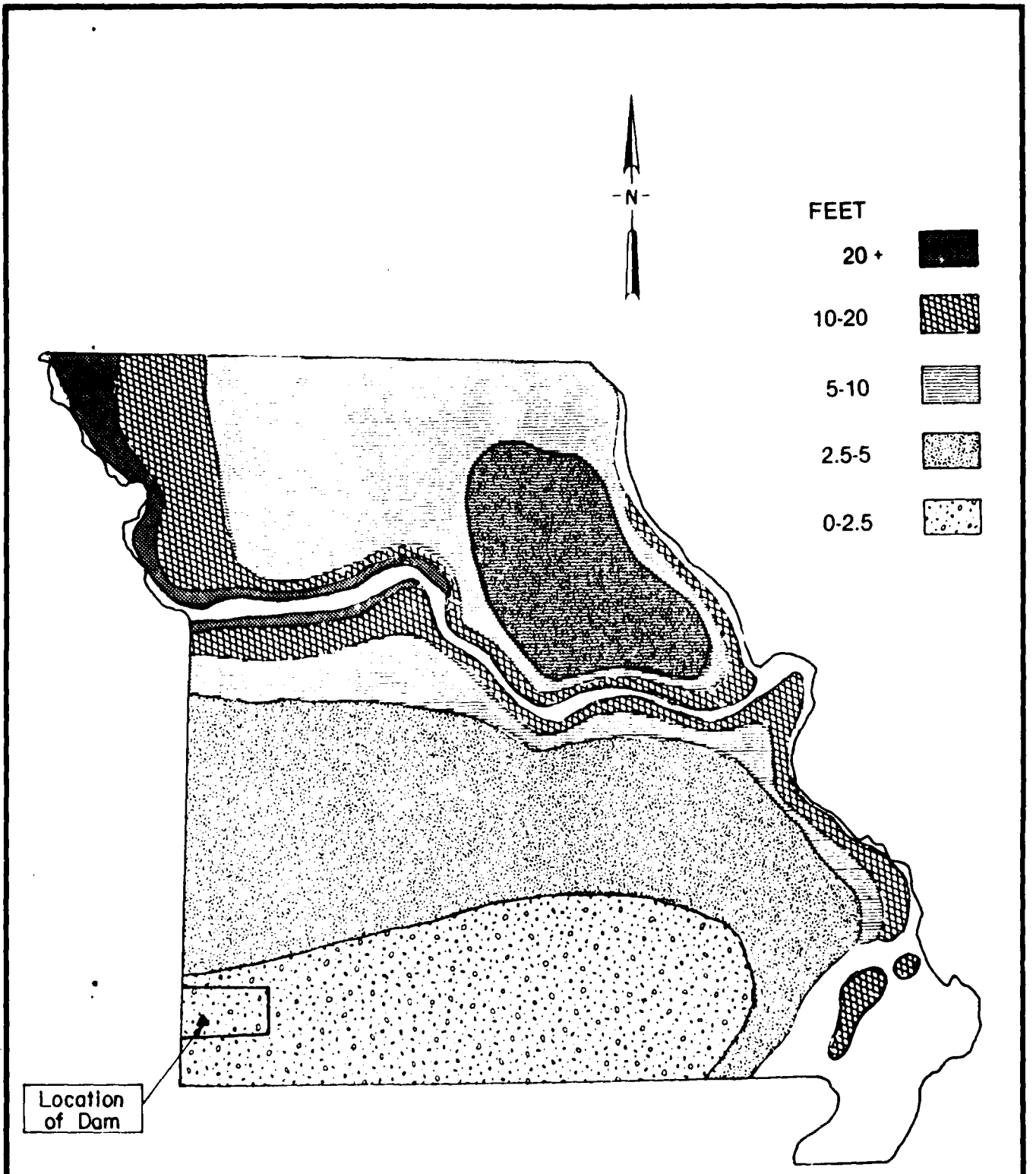
MAJOR GEOLOGIC REGIONS OF MISSOURI

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Newton County Structure E-1
Newton County, Missouri
Mo. I. D. No. 20511

SHEET 1, APPENDIX B



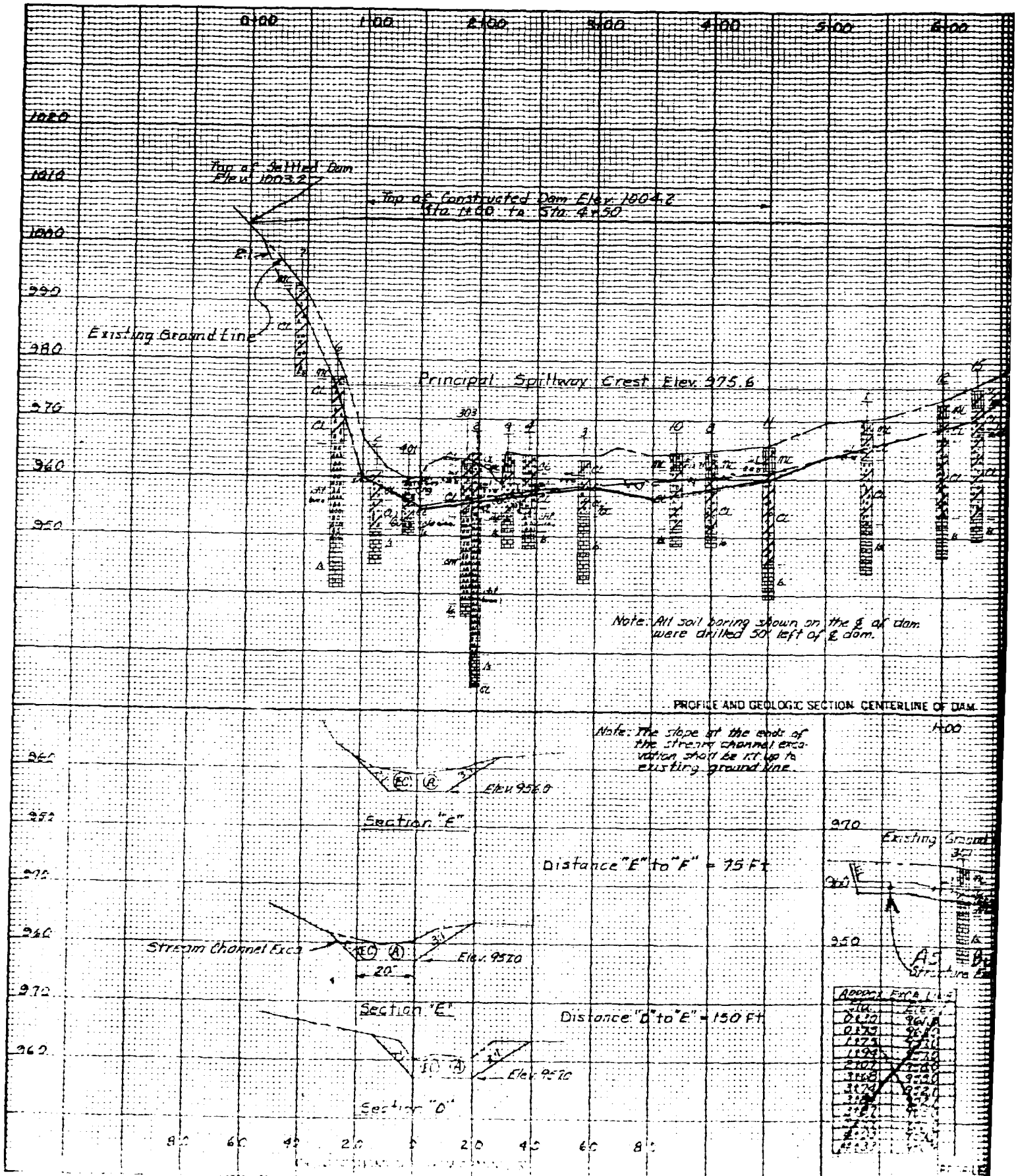
THICKNESS OF LOESSIAL DEPOSITS

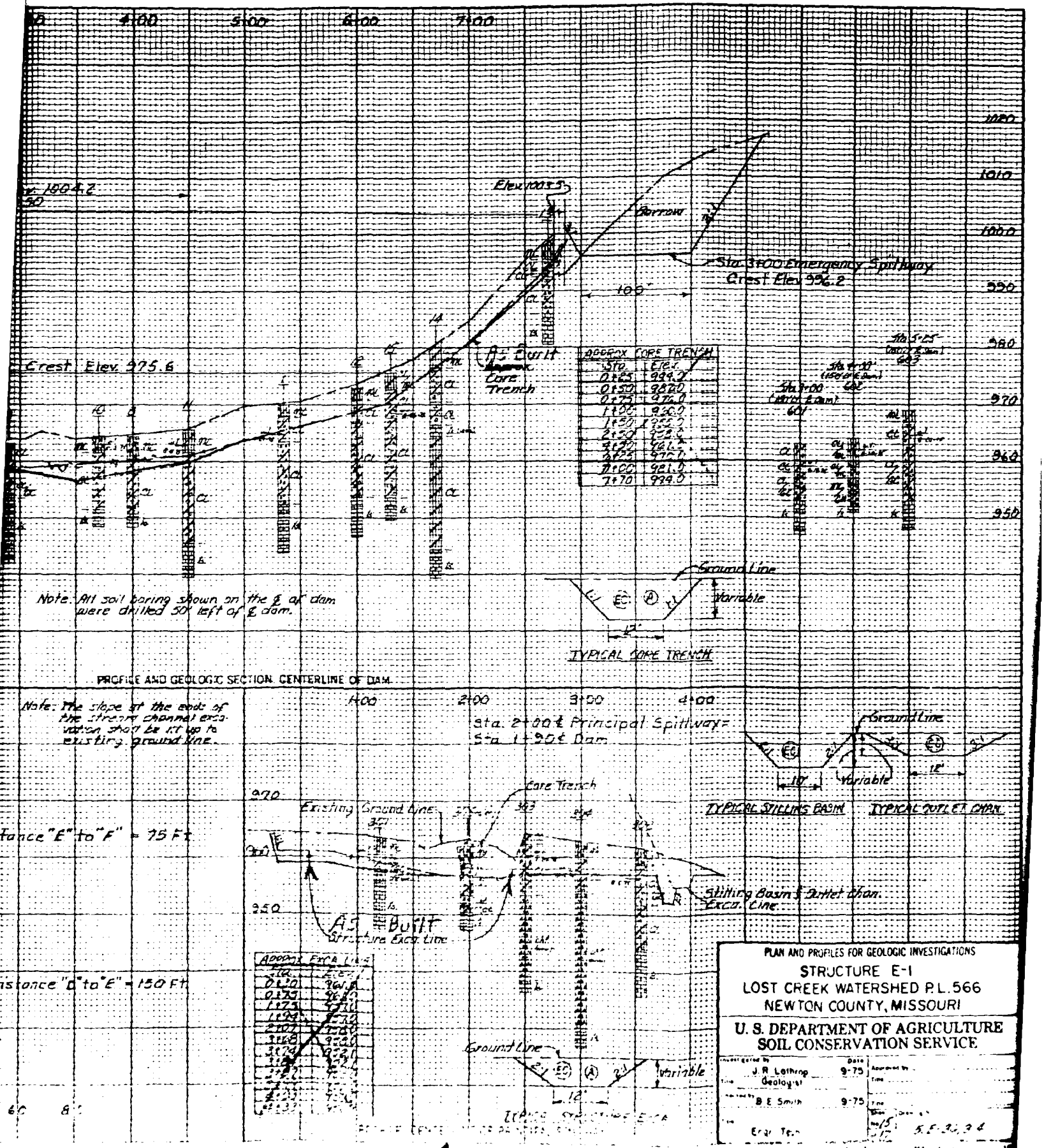
HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Newton County Structure E-1
Newton County, Missouri
Mo. I.D. No. 20511

SHEET 2, APPENDIX B


0+00
1+00
2+00
3+00
4+00
5+00
6+00
1020
1010
1000
990
980
970
960
950
Top of Settled Dam Elev. 1003.2
Top of Constructed Dam Elev. 1004.2 Sta. 1+00 to Sta. 4+50
Existing Ground Line
Principal Spillway Crest Elev. 975.6
Note: All soil boring shown on the ℄ of dam were drilled 50' left of ℄ dam.
PROFILE AND GEOLOGIC SECTION CENTERLINE OF DAM
Note: The slope at the ends of the stream channel excavation shall be cut up to existing ground line.
Elev. 956.0
Section "E"
Distance "E" to "F" = 75 Ft
Stream Channel Excv
Elev. 957.0
20'
Section "E"
Distance "D" to "E" = 150 Ft
Elev. 957.0
Section "D"
Existing Ground
Stream Line


Elev 1004.2
Elev 1005.5
Borrow
Sta 3+00 Emergency Spillway
Crest Elev 996.2
100'
Crest Elev. 975.6
As Built
Core Trench
APPROX CORE TRENCH
Sta Elev
0+25 959.2
0+50 958.0
0+75 957.0
1+00 956.0
1+50 955.2
2+00 954.2
2+50 953.4
2+75 952.7
3+00 952.0
3+50 951.0
3+70 950.0
Sta 0+00 (Axis of Dam) 60'
Sta 3+00 (Axis of Dam)
Sta 3+25 (150' ℄ Dam)
Note: All soil boring shown on the ℄ of dam were drilled 50' left of ℄ dam.
Ground Line
Variable
12'
TYPICAL CORE TRENCH
PROFILE AND GEOLOGIC SECTION CENTERLINE OF DAM
Note: The slope at the end of the stream channel excavation shall be fit up to existing ground line.
Sta. 2+00 ℄ Principal Spillway
Sta. 1+90 ℄ Dam
Core Trench
Existing Ground Line
As Built
Structure Excv. Line
Stilling Basin & Outlet Chan. Excv. Line
Ground Line
Variable
12'
APPROX EXCA LINE
TYPICAL STILLING BASIN
TYPICAL OUTLET CHAN.
tance "E" to "F" = 75 Ft
istance "D" to "E" = 150 Ft
PLAN AND PROFILES FOR GEOLOGIC INVESTIGATIONS
STRUCTURE E-1
LOST CREEK WATERSHED P.L. 566
NEWTON COUNTY, MISSOURI
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Prepared by J. R. Lathrop Geologist Date 9-75
Approved by Title Date
Designed by B. E. Smith 9-75
Title Engr. Tech
Date 5-5-76

ENGINEER'S REPORT

SITE E-1 LOST CREEK

1. STREAM CHANNEL - Stripping and foundation preparation and core trench excavation should eliminate all the stream channel cleanout needed.

2. DEPTH OF CORE - Recommend that the core trench be as shallow as possible to insure a safe dam.

3. UNDESIRABLE MATERIAL - There appears to be no large amount of undesirable material in the foundation area except for a minor concrete structure and silty material located in the spring area downstream from the centerline of the dam.

4. MATERIALS - Excavation from the core and emergency spillway may be used for fill material. Rock was encountered above grade in the upper exit section of the emergency spillway. Sufficient borrow material can be obtained by excavating the top of the hill upstream from the emergency spillway, 2 to 3 feet deep on the right side of the stream channel in the permanent pool area and approximately 6 to 1 slopes along the right abutment from Grid "C" to the emergency spillway.

5. CONDUIT - Due to class of structure the conduit will be reinforced 30 inch concrete pipe. Two locations were drilled out during site investigation and were considered very comparable. Recommend the original location be selected.

6. DRAINAGE - ~~The work plan recommended large blanket drains across the flood plain and up the abutments~~. Request laboratory recommendations as to the type and locations of drains needed for a safe dam.

7. Recommend that fill placement controls be ~~class C compaction or~~ Class A compaction with controls on the minus 3/4" fraction.

Joe A. Green, Project Engineer
September 11, 1975

Report and Recommendations from the State Design Engineer and the Engineering Specialist for Soil Mechanics

Site E-1, Lost Creek Watershed
Southwest RC&D, Missouri

The Operations Geologist requested our assistance because of the Tripoli in the foundation and the water supply spring.

The tripoli found in Missouri is a form of weathered chert. This was easily seen when the material was inspected at the site. This formation is not high quality tripoli and is not extensive. It occurs as a pocket under the principal spillway. The material is solid and will not consolidate or weather further. The top few feet are permeable (about 5 fpd) but this will not be a problem from either a construction or stability standpoint. Our conclusion is that the tripoli will not affect the structure and should be treated as ordinary bedrock.

The landowner had the following clause written into the easement he signed. "If within 5 years following the completion of the works of improvement, the flow of the natural spring, located between the fill site and the dwelling location on the farm, is terminated or substantially reduced due to the installation of the works of improvement; a well will be provided by the local organization." This spring seems to be originating in a gravelly pocket which could be an old stream channel. This gravel material contacts the bedrock and lies in a shallow depression in the limestone surface. Two drill holes, one on the ℄ of the dam and one on the ℄ of the drain borings, contacted the gravelly layer. Both of these holes caused the spring to become muddy. No other holes found the gravelly layer or muddied the spring. The water table at this site is quite high, 3 to 4 feet below the ground. We feel that a cutoff to waterline in the CL or GC material will be sufficient on this site. This will leave the gravelly layer intact to feed the spring and the spring may not even be effected by construction activities. The high water table is indicative of a very good chance for a full pool. We walked the stream channel and could find no indication that the stream channel was in any way connected to the aquifer that feeds the spring.

Borrowing should be limited in the pool area to preserve a blanket over the bedrock. The foundation underlying the site is about 12 feet deep across the floodplain. There is 2 to 4 feet of ML over 6 to 8 feet of gravelly, cherty, CL or GC. At the soil-bedrock interface there is a small amount of weathered bedrock. We obtained one undisturbed sample from the lower part of the ML stratum. The CL stratum was just to rocky to sample with a shelby tube. The foundation appears to be very good with adequate strength for a class c dam.

Foundation drainage will not be required on this site, in fact, a foundation drain may encourage flow under the dam. An embankment drain will probably be needed to meet class c stability requirements.

We are of the opinion that the problems mentioned above are not serious. The other springs mentioned in the geologist report are not hazardous to the dam. The spring upstream from ℄ station 3+30 is a wet, marshy area with no open flow. The spring at the base of the left abutment feeds directly into the stream channel and its flow was quite small. An extension of the embankment drain could intercept this flow and outlet in the stream channel below the dam.

The embankment will be a homogeneous fill consisting of gravelly CL from the borrow area on the right abutment. The CL has a rock content which varies between 10 to 40%. The red, waxy CL occuring just above the bedrock should be placed in the interior of the dam, preferably below the phreatic line. There will be ML borrowed from the pool area and placed as a shell section for vegetation.

Neil H. Randall
Head, Design Section

Michael M. Blaine
Engineering Specialist

Form SCS-376A
Sheet 1 of 10

10-59

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

S½ - 9

State Missouri County Newton ; ~~¼~~ N½ ~~¼~~ Sec. 16 , T 25 R 33W ; Watershed Lost Creek

Subwatershed _____ Fund class WF-08-2018 (FP-2, WP-1, etc.) Site number E-1 Site group I Structure class C

Investigated by _____ (signature and title), Equipment used Failing 1500 RD, D6C Cat. (type, size, make, model, etc.) Date 9-9-75

SITE DATA

Drainage area size 1.15 sq. mi., 736 acres. Type of structure Compacted Earth Purpose Floodwater Retarding

Direction of valley trend (downstream) South , Maximum height of fill 44 feet. Length of fill 830 feet.

Estimated volume of compacted fill required 108,383 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	60	10	17
Floodwater	398	31	37

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Ozark Highland Topography Rolling Attitude of beds: Dip SE Strike NE-SW

Steepness of abutments. Left 37 to 90 percent, Right 27 percent. Width of floodplain at centerline of dam 365 feet

General geology of site: This site is located upon an outcrop of the Warsaw formation of the Meramecian series and is Mississippian in age. Bedrock on the site is hardness 4 to 5 cherty limestone, hardness 5 chert and clay and hardness 1 to 2 very weathered tripolitic chert.

The site is approximately 1/8 mile west and on the upthrown side of the Seneca fault system. This major fault trends NE and SW in a straight line over an approximate distance of 8 to 10 miles. Minor faulting is present in the site area, however, no faulting was apparent under the ℄ dam alignment.

Cherty clay and chert is encountered at shallow depths on both abutments overlying hardness 4-5 limestone. Medium bedded hardness 4 cherty limestone and very weathered hardness 1-2 tripolitic chert is found at an average depth of 13' to 14' through the floodplain section.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-376B
REV. 2-64
SHEET 2 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE ℄ Dam

(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
Failing 1500 RD	15	2	1 (3" Shelby)	--	3
			1 (sack cores)		
TOTAL	15	2	2	--	3

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Soils developed above bedrock in the floodplain areas are a slightly clayey gravelly silt (ML) horizon overlying a gravelly to very gravelly clay (CL) horizon. In some holes, always directly on top of bedrock, a red-waxy slightly gravelly clay horizon was encountered. Average depth of the water level on the ℄ dam alignment is at an elevation of 960.0 ft. water was flowing in the channel at the time of the site investigation.

The gravel lenses are generally lenticular and discontinuous but some show continuity. In boring #11 at station 4+50 ℄ dam the gravel zone encountered at 14 to 15 ft. is probably an aquifer for the spring located approximately 260 feet down stream.

Average depth of the water level on the ℄ dam alignment is at an elevation of 960.0 feet.

Cherty clay and chert is encountered at shallow depths on both abutments, overlying limestone. A permeability test was conducted in boring #6 at station 0+77 ℄ dam. Permeability rates were moderately low. Circulation was lost in the limestone in three holes #13, #202 and #208 on the right abutment at approximate elevation of 981.0 to 983.0.

Bedded, hardness 4 cherty limestone and very weathered hardness 1-2 tripolitic chert is found at an average depth of 13' to 14' through the floodplain section. Cores were taken of the hardness 1-2 chert in boring #2 and #304. Pressure premeability tests were taken in the very weathered chert in boring #2. Permeability rates were moderately high in the upper portion and decreased with depth.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-376B
REV. 2-64
SHEET 3 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Principal Spillway (1+90 ℄ Dam)

(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
	EXPLORATION	SAMPLING	UNDISTURBED (STATE TYPE)	DISTURBED LARGE	DISTURBED SMALL
Failing 1500 RD	5	1	1 sack cores		
TOTAL	5	1	1		

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Hardness 4-5 cherty limestone and or hardness 1-2 very weathered tripolitic chert is at an average depth of 10 feet along this alignment. Boring #302 encountered hardness 4 limestone at 18 feet depth. Very weathered tripolitic chert was encountered in boring #304 at 9 feet to 32 feet depth. Diamond cores were taken of this material in the boring.

Average water table elevation along this alignment is at 959.0 feet.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-376B
REV. 2-64
SHEET 4 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Alternate Principal Spillway (2+60 ℄ Dam)

(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
Failing 1500 RD	5	1	--	2	-
TOTAL	5	1	--	2	-

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Comparable and similar foundation materials are encountered along this alignment as those discussed in the summary sheet on the original principal spillway @ station 1+90 ℄ dam.

An estimated additional 250 feet of channel excavation will be necessary if this location is utilized.

Water levels along this alignment varied from an elevation of 961.0 feet to 941.0 feet.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-376B
REV. 2-64
SHEET 5 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Drain Borings
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
Failing 1500 RD	3	2	--	--	6
TOTAL	3	2	--	--	6

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Three (3) drain borings were drilled for correlation and control purposes. Generally very similar soil materials were found in these borings as those encountered along the ℄ dam alignment.

Average water table elevation in the drain borings was at 960.0 feet.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-376B
REV. 2-64
SHEET 6 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Springs

(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
TOTAL					

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Numerous springs were present on this site.

The spring located approximately 260 feet downstream from station 4+20 ℄ dam is currently being used for house and garden needs. This spring reportedly has never been dry in the 100 year history of the landowner's family. When boring #11 located at station 4+50 ℄ dam was drilled the spring turned muddy. A clayey gravel zone above bedrock is probably the aquifer for this spring. Water temperature was at 63° F.

The spring in the draw to the right below the dam functions only during wet periods.

A spring is present at approximately 25 feet upstream station 3+30 ℄ dam which has fed a breached shallow pond, below the discharge. The old dam is approximately 100 feet downstream from the spring, about 4 to 5 feet high and according to the landowner was constructed in the year 1869.

A spring was noted at the base of the left abutment approximately 50 feet downstream station 1+00 ℄ dam. Water temperature of this spring was 64° F. at the time of the site investigation.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-376B
REV. 2-64
SHEET 7 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Stream Channel
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
Failing 1500 RD	1	--			
TOTAL	1	--	--	--	--

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Sandy cherty gravel was on the surface of the channel and extended to a depth of 3 feet. Underlying the surface gravel, from 3 to 7 feet depth was a gravelly clay (CL). From 7 to 8 feet, weathered chert was encountered on top of limestone bedrock, and cherty limestone was logged at 8 feet depth.

The stream was flowing clear 64° water at the time of the site investigation. The landowner reports the flow as being continuous except during the dry 1934 year the channel was almost dry.

Water was not present in some channel sections upstream as the flow goes underground.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-376B
REV. 2-64
SHEET 8 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Emergency Spillway
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
D6C Cat	1	1	--	2	--
Failing 1500 RD	9	1	--	1	--
TOTAL	10	2	--	3	--

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Forebay and Control Section

A thin mantle of cherty silt (ML) overlies a brown-red very cherty clay (CL) horizon. The second horizon extends to an average depth of 4 to 5 feet. Below the brown cherty clay a red waxy tenaceous cherty clay (CL) is encountered. This horizon is less cherty with depth. The red-waxy clay extends to below proposed grade in this area.

Upper Exit Area

Hardness 4-5 cherty limestone bedrock is encountered a few feet above proposed grade in this area.

Borings #202 and #208 Lost circulation while drilling. However, no measurable voids were encountered.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FORM SCS-3768
REV. 2-64
SHEET 9 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Borrow Area
(CENTERLINE OF DAM, PRINCIPAL SPILLWAY, EMERGENCY SPILLWAY, THE STREAM CHANNEL, INVESTIGATIONS FOR DRAINAGE OF STRUCTURE, BORROW AREA, RESERVOIR BASIN, ETC.)

DRILLING PROGRAM

EQUIPMENT USED	NUMBER OF HOLES		NUMBER OF SAMPLES TAKEN		
			UNDISTURBED	DISTURBED	
	EXPLORATION	SAMPLING	(STATE TYPE)	LARGE	SMALL
Failing 1500 RD	10	2	--	5	--
TOTAL	10	2	--	5	--

SUMMARY OF FINDINGS
(INCLUDE ONLY FACTUAL DATA)

Three soil horizons generally comprise the materials of the borrow. The surface horizon averaging 3 to 4 feet in depth is a brown clayey silt (M or CL-ML). The second horizon is a brown-red gravelly clay (CL or CL-GC) that extends to an average depth of 7 to 8 feet. The third horizon is a red waxy slightly cherty clay (CL). This horizon directly overlies bedrock. In the higher elevations, the second horizon is more cherty, more plastic and redder in color.

Two borings #101 and #110 encountered water at 6.9 feet and 5.5 feet respectively. Other borrow borings were dry. However, the borrow holes in the floodplain caved between 6 and 9 feet at 72 hours.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-376C
REV. 2-64
SHEET 10 OF 10

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED	SUBWATERSHED	COUNTY	STATE
Lost Creek		Newton	Missouri

SITE NO.	SITE GROUP	STRUCTURE CLASS	INVESTIGATED BY: (SIGNATURE OF GEOLOGIST)	DATE
E-1	I	c		9-9-75

INTERPRETATIONS AND CONCLUSIONS

℄ Dam - The recommended minimum cutoff trench depths should provide an adequate cutoff. The trench will bottom on both abutments in cherty clay and through the floodplain section in gravelly clay material. Some seepage may be expected in the gravelly clay through the floodplain section; and if the cherty limestone is exposed on the right abutment some highly permeable strata may be uncovered. It is not anticipated that the very weathered tripolitic chert material encountered around station 2+00 ℄ dam will constitute any particular stability or construction problem.

Principal Spillway - Location alignment and foundation are satisfactory, and the location at station 1+90 ℄ dam is adequate. Trench depths should eliminate the ML surface material found along this alignment.

Alternate Principal Spillway - This alignment at station 2+60 ℄ dam is not recommended. The foundation along the alignment is comparable to the original alignment and additional channel excavation will be needed.

Drainage - Should be considered from the left to the right abutment.

Stream Channel - 1 to 2 foot removal of the surface gravel at all sections is suggested.

Borrow - Ample materials are available within the suggested borrow limits to construct the dam. More plastic materials are found in the higher elevations; on the right of Emergency Spillway area and on the right flank of Grid "A", "B" and "C". Because of the water table and the advantages of a blanket cover it is suggested that: borrowing be limited in the floodplain areas to a depth of 4 feet or less.

Emergency Spillway - As presently designed an estimated 16,000 cu. yds. of excavation will be needed from the Emergency Spillway area. An estimated 500 cy. yds. of this amount may be rock excavation. The rock excavation was encountered above proposed grade in the upper exit area. Modification of construction design could be considered.

RANDALL NR

File 13-18

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE - Soil Mechanics Laboratory

800 "J" Street, Lincoln, Nebraska 68508

SUBJECT: ENG 13-18, Missouri WF-08, Lost Creek, Site E-1 (Newton County) - Supplemental Report

DATE: May 11, 1977

TO: James M. Dale
State Conservation Engineer
Soil Conservation Service
Columbia, Missouri

INTRODUCTION

The slope stability analysis of this site was originally reported without considering seismic forces. A telephone call from Mike Blaine was received on May 5, 1977, requesting a seismic evaluation using a 0.05G seismic force.

DISCUSSION

The same shear parameters were used for the analysis as in the previous analysis. This maximum section at Station 1+30 was reported to have a factor of safety of 1.50 with a 50-foot downstream berm and a foundation drain. The 0.05G seismic force applied to this failure condition reduces this factor of safety to 1.32.

The floodplain section at Station 2+65 was reported to have a factor of safety of 1.50 with a 36-foot downstream berm and a drain. This factor will reduce to 1.32 with the same seismic force applied.

Prepared by:

Robert F. Hays
Civil Engineer

Reviewed and Approved by:

Tom P. Dunnigan
Head

cc: Mike Blaine, Columbia
Eugene J. Pope, Lincoln, NE

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE - Soil Mechanics Laboratory
800 "J" Street, Lincoln, Nebraska 68508

SUBJECT: ENG 13-18, Missouri WF-08, Lost Creek, Site E-1 (Newton County) - Supplemental Report

DATE: September 27, 1976

TO: James M. Dale
State Conservation Engineer
Soil Conservation Service
Columbia, Missouri

This report supplements our soil engineering report dated February 25, 1976, and is prepared in response to your letter of September 16, 1976.

In your letter you requested additional slope stability analyses based on the following conditions:

1. Phreatic line developed from the crest of the principal spillway (el 975.6) and egressing into a drain located 75 feet downstream from centerline of dam.

2. Use of NAVDOCKS sliding block procedure with conditions per trials No. 13A(down) and 11 (up) in the original analysis.

3. Minimum safety factors as contained in Technical Release 60.

Forms SCS-ENG-357, consisting of three sheets, are attached. They contain the adopted design data and summarize the results of this additional analysis at both the maximum and floodplain sections.

Upstream. The analysis indicates that a $2\frac{1}{2}$:1 slope above and a 3:1 slope below a 15-foot wide berm at elevation 975.6 has an adequate safety factor for the assumed conditions.

Downstream. The analysis indicates that a $2\frac{1}{2}$:1 slope above and below a 14-foot wide berm has an adequate safety factor for the assumed conditions.

The above embankment cross-section does not consider the design requirements stipulated in EM Technical Note-ENG-LI-20 (Rev. 1/74) for a hazard class (c) dam located in an earthquake design class 1 region.

Prepared by:

Donald M. Sandberg
Civil Engineer

Reviewed and Approved by:

Lorn P. Dunigan
Head

Attachments: Form SCS-ENG-257, Summary - Slope Stability Analysis, 3 sheets

cc: Buell M. Ferguson, Lincoln, NE

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE - Soil Mechanics Laboratory
800 "J" Street, Lincoln, Nebraska 68508

SUBJECT: ENG 13-18, Missouri WF-08, Lost Creek, Site E-1 (Newton County) **DATE:** February 25, 1976

TO: James M. Dale
State Conservation Engineer
Soil Conservation Service
Columbia, Missouri

ATTACHMENTS

1. Form SCS-ENG-354, Soil Mechanics Laboratory Data, 2 sheets
2. Form SCS-ENG-355A & 355B, Triaxial Shear Test Data, 3 tests, 7 sheets
3. Form SCS-ENG-352, Compaction and Penetration Resistance, 2 sheets
4. Form SCS-ENG-357, Summary - Slope Stability Analysis, 6 sheets
5. Figures 1 and 2, 2 sheets

INTRODUCTION

The proposed dam is a hazard class c floodwater retarding structure. It has a maximum height of about 44 feet, a crest length of about 830 feet, and a drainage area of 1.15 square miles.

This site is located in earthquake design class 0 region. The geologic report indicates that there is minor faulting in the area but none at the dam site.

There are several springs at the site as pointed out in the geologic report. Flow in one spring must be maintained per the easement.

DISCUSSION OF DATA

FOUNDATION

A. Bedrock. Bedrock consists of weathered chert overlying limestone. See the geologic report for details. At the centerline of the dam, bedrock lies below the ground surface at depths as follow:

1. Left abutment . . . . . ≥11 feet;
2. Floodplain . . . . . 10 to 20 feet; and
3. Right abutment . . . . . 12 to 36 feet.

B. Soil Classification.

1. Left abutment. (Approximate Station 0+00 to 1+00). No samples were submitted. Soil is logged as ML (surface) with underlying CL to the weathered chert.

2. Floodplain. (Approximate Station 1+00 to 4+50). One core and eight bag samples were submitted to the laboratory. The surface materials are logged as ML (2-4 feet thick) or CL, except in the channel where 3 feet of gravel were encountered. Underlying material down to the bedrock is logged as CL and CL/GC, much of which is gravelly to very gravelly.

The surface soils are represented by Samples 76W784A (306-1), 76W789 (601-1), and 76W792 (602-1). Fines vary from 77-100%, LL's from 31-43, and PI's from 11-24. All soils classify as CL's.

The underlying soils are represented by samples as follows:

Sample No.		Depth	USCS	LL/PI	Fines	Sand	Gravel	Maximum Size
Laboratory	Field	(ft)			(%)	(%)	(%)	(in.)
76W784B	306-2	3-10	GC	41/22	49	23	28	3
785	2-1	4-5.5	CL	36/14	85	12	3	$\frac{1}{2}$
786	2-2	7-7.5	CL	39/18	72	24	4	3
790	601-2	3-5	GC	37/18	47	19	34	$1\frac{1}{2}$
791	601-3	5-10	GC	40/20	37	22	41	$1\frac{1}{2}$
793	602-2	4-7	CL	35/16	68	13	19	$1\frac{1}{2}$

Except for core sample 76W785, all of the above samples are bag samples.

3. Right Abutment. (Approximate Station 4+50 to 8+30). Samples 76W787 (13-1) and 76W788 (13-2) represent the near surface and underlying soil to bedrock. These samples classify as CH (LL = 70, PI = 41) and CL (LL = 45, PI = 22), respectively. The former has 86% fines and 5% gravel to 1-inch size, whereas the latter has 50% fines and 12% gravel to 1-inch size. Consistency of surface ML's was logged generally as medium, and underlying CL's as stiff.

Laboratory dispersion tests indicate that these samples are not dispersed.

C. Dry Densities. The dry density of Sample 76W785 (2-1) from core opening was 1.63 g/cc. Dry densities of six shear specimens ranged from 1.53 to 1.65 g/cc. The soils represented by this sample generally have medium to stiff consistency according to the logs.

The surface ML's were not sampled; logs generally describe the consistency as medium.

D. Permeability and Water Table. No laboratory permeability tests were made. The geologic report states that a field test in TH 6 (left abutment) indicated moderately low permeability values in the 12-36 foot depth interval.

Circulation was lost in TH 13 at elevation 981, TH 202 at elevation 984, and TH 208 at elevation 995--all holes being in the right abutment and emergency spillway area. These losses were at elevations above the permanent pool (el. 975.6). Also, circulation was lost in TH 306 at elevation 938 approximately; this hole is 175 feet downstream from the downstream toe of the embankment.

In the cross section represented by TH 309, 306, 310, 307, and 308 (Station 2+60 ℄ dam), the groundwater level ranges from 4 to 6 feet below the ground surface between TH 309 and 307. No groundwater is indicated in TH 308 to a depth of 20 feet at which depth circulation was lost, as pointed out in the preceding paragraph.

In the cross section represented by TH 301, 303, 304, and 302 (Station 1+90 ℄ dam), the groundwater level ranges at depths of 4 to 6 feet (el. 961-956).

Groundwater was encountered in the lower portion of the right abutment at elevation 963-968.

The geologist reports four springs at or near the site: one (perennial) about 250 feet downstream from ℄ station 4+00; one to the right of the creek downstream (location not given); one 25 feet upstream from ℄ station 3+30; and one 50 feet downstream from ℄ station 1+00. The geologic report indicates that the aquifer that feeds the perennial spring lies at about elevation 951 in TH 11. Fifteen minutes after drilling TH 11 the water in the spring turned muddy. No communication between other test holes and the spring is indicated in the geologic report.

E. Consolidation. A consolidation test was not made. The unit consolidation of the lower density portion of Sample 76W785 (2-1) is estimated at about 3.5% and the higher density portion at about 2.5%. These estimates are based on data from the triaxial tests and an embankment load of 5 ksf (40-foot embankment). An S-value of 0.4 foot can be used for pipe elongation calculations; this value is based on 11 feet of compressible fine-grained material like Sample 76W785. Actually much of the foundation is logged as gravelly to very gravelly, so data from Sample 76W785 is probably not representative.

F. Shear Strength. It is impossible to obtain three triaxial shear specimens at the same level from a 2 7/8-inch diameter sample. Two tests, as described below, were made on Sample 76W785 (2-1). Both tests were

the consolidated undrained type with measurements of shearing pore pressures. Specimens were 1.4 inch in diameter. Near-saturation was obtained as indicated by the B parameters which ranged from 0.95 to 0.99. See Forms SCS-ENG-355A and -355B attached.

Data from the first test (T-1) were interpreted as follows: total stress ϕ = 14.5°, c = 250 psf; and effective stress $\bar{\phi}$ = 32°, $\bar{c}$ = 175 psf. Due to variations in specimen dry densities and the total stress Mohr circles, plus the need for wide berms as discussed in the slope stability section, a second test was made.

Data from the second test (T-2) were interpreted as follows: total stress ϕ = 16°, c = 800 psf; and effective stress $\bar{\phi}$ = 32°, $\bar{c}$ = 175 psf. Total stress shear parameters in test T-2 are higher, especially cohesion, than values in test T-1. However, effective stress shear parameters are the same in both tests.

The six total stress Mohr Circles from the two tests are plotted on Form SCS-ENG-355A marked "Composite T-1 and T-2." The Mohr envelope for four circles indicates ϕ = 18°, c = 725 psf with specimen dry densities ranging from 1.59-1.65 g/cc. The Mohr envelope for the other two circles indicates ϕ = 14.5°, c = 250 psf with specimen dry densities of 1.53 and 1.54 g/cc.

Thus, these tests appear to indicate a range in CU shear strength for lower and higher dry densities or for different materials.

EMBANKMENT

A. Classification. Five large-bag samples were received. Large-bag sample 104-2, 7-13 foot depth, was not received. Borrow will be obtained from the emergency spillway excavation and uphill from it, floodplain in pool area, and upstream side of right abutment in pool area. No quantities were given. See Form SCS-ENG-354 and Figure 1 for gradation and Atterberg limits information.

Emergency spillway materials are represented by Samples 76W794 (201-1) and 76W795 (201-2). These samples classify as GP-GM and GC, have PI's of 5 and 24, contain 14% and 25% cobbles, and have 44% and 41% finer than the 3/4-inch sieve, respectively. Sample 76W794 (201-1) has only 7% fines. These samples did not contain the waxy red clay as was indicated in logs of some of the other test holes in the emergency spillway.

Floodplain materials are represented by Samples 76W796 (101-2) and 76W797 (101-3). They classify as SC and CH, have PI's of 16 and 32, have 40% and 53% fines, and have 94% and 98% finer than the 3/4-inch sieve, respectively. Sample 76W797 almost classifies as a SC or GC and may contain some waxy red clay since the fines are highly plastic. Groundwater at the time of investigation was about 5-7 feet below the ground surface.

Upstream right abutment materials are represented by Sample 76W798 (104-1). It classifies as a CL (almost a SC), has a PI of 16, 51% fines, and 100% finer than the 3/4-inch sieve.

The three samples from the pool area are considerably finer than the emergency spillway samples. (See Figure 1.) The spillway samples contain from 56-59% sizes, including cobbles, larger than the 3/4-inch sieve.

B. Compacted Moisture-Density and Relative Density. Two compaction tests (ASTM D-698) and one relative density test were performed. See attached Forms SCS-ENG-352 for compaction test results. The relative density test was made due to the small amount of fines in 76W794 and inability to perform a standard compaction test. A summary of test and field data follows:

Sample No.		Sample Depth (ft)	Std. Compaction (D-698)				Relative Density	
Laboratory	Field		Fraction Tested	Method	Max. γ_d (pcf)	w_o (%)	Min. γ_d (pcf)	Max. γ_d (pcf)
76W-794	201-1	0.5-4.5	-1½"	--	--	--	83.1	109.4
796	101-2	3-8	-3/4"	C	112.5	14.0	--	--
798	104-1	2-7	-#4	A	111.0	16.0	--	--

The moisture-density curve for Sample 76W796 peaks abruptly, indicating relatively narrow moisture limits for compaction control.

Bulk dry densities of plus No. 4 materials in the preceding table varied from 128.5 to 136.7 pcf. Absorption of the same fractions varied from 5.7% to 9.3%. See attached Forms SCS-ENG-354.

C. Permeability and Consolidation. No tests were performed. Permeability of materials like 76W796 through 798 should be low at densities ≥ 95% ASTM D-698. Using data from the triaxial shear test on 76W796, unit consolidation of the embankment materials at maximum fill height, compacted to 95% or more ASTM D-698, is estimated at 0.01 ft/ft.

D. Shear Strength. A consolidated undrained triaxial test with measurement of shearing pore pressures was made on the minus No. 4 fraction of Sample 76W796 (101-2). Specimens were 1.4 inch in diameter; they were compacted to 95% of ASTM D-698 at molding moisture of 17.8%. See Forms SCS-ENG-355A and -355B attached. The B parameters of 0.94 to 0.98 indicate that near saturation was obtained by backpressuring. Shear parameters as follows were interpreted from test results: total stress ϕ = 14°, c = 1,125 psf; effective stress $\bar{\phi}$ = 29°, $\bar{c}$ = 475 psf.

SLOPE STABILITY ANALYSES

Slope stability analyses were made at two sections: maximum ℄ station 1+30 and floodplain ℄ station 2+65. Two circular arc and one sliding block procedures were used--the latter because the thickness of foundation soil is relatively thin. Two sets of foundation shear parameters, as discussed under "foundation shear strength," were used. See attached Forms SCS-ENG-357 for a summary. A discussion of the results follows:

1. Maximum Section (Station 1+30 ℄ dam).

   a. Shear parameters (foundation ϕ = 14.5°, c = 250 psf; embankment $\bar{\phi}$ = 29°, $\bar{c}$ = 475 psf).

      (1) Upstream slope: full drawdown from elevation 996.2. Requires 60-foot berm at elevation 975.6 with 3:1 slope below berm and 2½:1 slope above to obtain a safety factor of 1.35. (See trial No. 12 on summary form 357.)

      (2) Downstream slope: steady seepage from elevation 996.2 and drain at $c = 0.6\,b$. Requires 50-foot berm at elevation 973.3 with 2½:1 slopes above and below the berm to obtain a safety factor of 1.50. (See trial No. 15.)

   b. Shear parameters (foundation ϕ = 18°, c = 725 psf; embankment $\bar{\phi}$ = 29°, $\bar{c}$ = 475 psf).

      (1) Upstream slope: full drawdown from elevation 996.2. Requires 15-foot berm at elevation 975.6 with 2½:1 side slopes above and below the berm. (See trial No. 11A.)

      (2) Downstream slope: steady seepage from elevation 996.2 and drain at $c = 0.6\,b$. Requires 10-foot berm at elevation 973.3 with 2½:1 side slopes above and below the berm. (See trial No. 13B.)

2. Floodplain Section (Station 2+65 ℄ dam).

   a. Shear parameters (foundation ϕ = 14.5°, c = 250 psf; embankment $\bar{\phi}$ = 29°, $\bar{c}$ = 475 psf).

      (1) Upstream slope: full drawdown from elevation 996.2. Requires 30-foot berm at elevation 975.6 with 3:1 slope below berm and 2½:1 slope above the berm to obtain a safety factor of 1.35. (See trial No. 17.)

(2) Downstream slope: steady seepage from elevation 996.2 and drain at c = 0.6 b. Requires 35-foot berm at elevation 973.3 with 2½:1 side slopes above and below the berm. (See trial No. 20.)

b. Shear parameters (foundation ϕ = 18°, c = 725 psf; embankment $\bar{\phi}$ = 29°, $\bar{c}$ = 475 psf).

No analyses were run, but safety factors will be adequate in view of the analyses in paragraph 1 b (1) and 1 b (2) above.

The low shear strength in the foundation (triaxial test T-1) necessitates (1) wider upstream and downstream berms, and (2) flattening of the upstream slope below the berm in comparison with the values proposed on Form SCS-356.

SEEPAGE ANALYSIS

Due to lack of sufficient data, a seepage analysis has not been made. Nothing was given in the geologic report on origin of foundation soils, but we assume that some alluvial material is present along with the residual soils. Logs indicate zones of very gravelly soil but do not indicate whether clean or highly permeable layers of sand gravel exist. It is not unreasonable, particularly if some soils are alluvial, that highly permeable layers exist. The perennial spring is evidence that somewhere in the foundation there is a continuous layer(s) of relatively high permeability beneath the proposed dam.

If a highly permeable layer(s) occurs at a relatively shallow depth in the foundation or abutments, the reservoir head could cause high uplift pressure beneath the ML/CL blanket at or near the downstream toe of the embankment. For example, a low factor of safety against heaving at the toe is indicated when the following assumptions are made: head = 33 feet; blanket thickness = 10 feet; aquifer thickness = 2 feet; aquifer to blanket permeability ratio = 1,000; and buoyant blanket. These are reasonable assumptions.

SETTLEMENT ANALYSIS

A settlement analysis was not made due to lack of sufficient data.

CONCLUSIONS AND RECOMMENDATIONS

A. Site Preparation. It is suggested that (1) the gravel and other highly permeable material in the present channel be removed from the cutoff to the upstream toe, and (2) the steep slope in the lower portion of the left abutment be flattened to 1:1 or flatter. Normal stripping operations should remove undesirable material from the marshy area just upstream from Station 3+00 ℄ dam.

B. Cutoff. A partial cutoff through the surface ML and CL above the water table in the floodplain is probably adequate, as recommended in the engineer's report. This should not interfere with the downstream spring. We are not sure what effect, if any, the added weight of the dam and potential reduction in permeability of the aquifer will have on flow to this spring. Due to the shallow cutoff, lack of foundation drain, and gravelly seams in the foundation, wet spots may develop in the floodplain downstream from the dam when the reservoir level is raised. We do not know what bearing this may have on the buildings immediately downstream from the dam. A shallow cutoff in the abutments through the ML into the CL should be adequate.

C. Drainage. An embankment drain is needed for slope stability. It is suggested that this drain be located at c = 0.6 b. It need not extend into the foundation. The volume of surface material like Sample 76W794 (201-1) is not known. It appears that material like this sample can be used for the drain. Surface foundation materials like Sample 76W734A (306-1) have intermediate PI values, so a filter such as fine aggregate ASTM C-33 should be placed between the drain material and the foundation material. See the sketch in the upper left-hand corner of Figure 2. The borrow materials (other than 76W784A) have PI values greater than 15. A filter is not needed between the embankment and the drain material under these circumstances. The drain should extend up the abutments to about elevation 975.

As suggested in the engineer's report, the spring about 50 feet downstream from Station 1+00 ℄ dam can be connected to the embankment drain.

D. Principal Spillway. The location of the principal spillway normal to Station 1+00 ℄ dam appears to be satisfactory. The bedrock drops off considerably below the lower half of the downstream slope, but the embankment load is decreasing, so undesirable settlement may not be a problem. With the invert at the outlet end at elevation 961.2, it appears that little excavation after normal stripping will be required. Horizontal strain is estimated at about 0.003 ft/ft. A $\bar{\phi}$ value of 30° is suggested for pipe loading calculations. Fill and backfill around the pipe can consist of material like 76W798 (104-1) compacted to 95% of standard at a moisture content of optimum or greater.

E. Embankment Design. Volumes of the various borrow materials are not known. The water table in the floodplain is relatively high, thus limiting depth of borrow. We concur with the engineer's suggestion that a soil blanket be left over the bedrock, perhaps 3-4 feet minimum thickness. No formal zoning of the embankment is proposed.

1. Placement of Materials. High-plasticity soils should be placed in the lower portion of the center of the embankment and in the interior upstream portion of the embankment. Placement of the waxy red clay in the low center of the fill may be a problem since it is generally located at some depth in the borrow profiles. Materials like Samples 76W796, 797, and 798 can be placed in the center or upstream portion of the embankment.

   Material like 76W794 (201-1), if not used in the drain, can be placed in a downstream toe section. Material like 76W795 can be placed in the lower portion of the downstream section above and upstream of 76W794 or, if enough material is available, in the entire downstream section.

   Fill density of material like 76W794 (201-1) and 76W795 (201-2) can be controlled by a method specification. Control of fill density of materials like 76W796 (101-2), 76W797 (101-3), and 76W798 (104-1) can be on the minus 3/4-inch or minus No. 4 fraction per ASTM D-696, Methods C or A, respectively. Placement moisture content should be optimum or higher.

2. Slopes and Berms. It is doubtful that weak materials, as indicated by triaxial test T-1 (the lower portion of core 76W788, 2-1), can be differentiated in the field. Thus, weak materials probably cannot be removed with any degree of certainty. Two alternatives, based on present sampling and laboratory testing, are proposed.

   Alternate No. 1. Assuming the weak foundation material is not removed, the following embankment cross section is suggested: upstream--60-foot wide berm at elevation 975.6 with 3:1 slope below the berm and 2½:1 slope above; downstream--50-foot wide berm at elevation 973.3 with 2½:1 slopes above and below the berm and an embankment drain at e = 0.6 b. The maximum section is only about 50 feet long at centerline of dam. A 30-foot upstream and a 35-foot downstream berm provide safety factors of 1.21 and 1.42, respectively; these berms provide adequate safety factors of 1.35 and 1.50 in the floodplain section. The width of the berms could be varied, i.e. use a greater width in the maximum section and a lesser width in the floodplain section. Using the weaker foundation strength in the analyses may seem conservative in view of the possibly stronger gravelly and very gravelly material in the lower portion of the clay stratum; however, it only takes a thin layer of weak material to provide a plane for sliding.

   Alternate No. 2. Assuming that the weak foundation material is removed, the following embankment cross section is suggested: 15-foot upstream berm at elevation 975.6, 10-foot downstream

berm at elevation 973.3, $2\frac{1}{2}$:1 slopes both sides, and an embankment drain beneath the downstream slope at c = 0.6 b. This is the cross section proposed on Form SCS-356.

Another alternative is to do more sampling of the foundation soils and testing of undisturbed samples in an effort to delineate weak materials.

3. Overfill. An overfill allowance of one foot between ℄ Station 1+00 and 4+50 is suggested to compensate for residual settlement after completion of the embankment.

Prepared by:

Donald M. Sunlberg
Civil Engineer

Reviewed and Approved by:

Iorn P. Dunnigan
Head

Attachments

cc:
Joe A. Green, Mt. Vernon (2)
Buell M. Ferguson, Lincoln, NE

SCS-ENG-354 Rev. 3-70 File Code ENG-13-19

Ht. = 44' 108,383 cu yd

Class C Floodwater Retarding

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

12/4/75 MISSOURI

LABORATORY SAMPLE NUMBER	FIELD NUMBER	LOCATION AND DESCRIPTION	DEPTH	FIELD CLASSIFICATION	MECHANICAL ANALYSIS: GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT PASSING BY DRY WEIGHT — FINES	SAND	GRAVEL	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	UNIFIED CLASSIFICATION	SOLUBLE SALTS %	DISPERSION %
76W		Lost Creek Site: F-1										
784A	306.1	℄ Dam, 2+62 (alt. prin. Spwy.) L. Bag	1-3'	ML	16 24 50 73 89	86 88 89 90 91 92	94 95 97 98 100	31	11	CL		
784B	306.2	" " " L. Bag	3-10'	CL	16 21 37 45 49	50 52 54 58 63 72	82 86 91 95 99 100	41	23	CC		
785	2-1	℄ Dam, 1+98 ℄ Dam (3" shelb; sample) Undist	±5.5'	CL	23 31 53 70 85	87 90 92 94 96 97	98 100	36	14	CL		7
786	2-2	" " S. Bag	7-7.5'	CL	22 32 58 71 79	85 81 84 87 95 96	97 97 98 99 100	32	15	CL		6
787	13-1	℄ Dam, 7+70 ℄ Dam S. Bag	3-5'	CL	41 72 82 85 87	87 88 87 90 95 95	98 98 100	70	41	CH		
788	13-2	" " S. Bag	6-12.5'	CL	22 38 51 55 57	61 65 68 73 77 88	95 99 99 100	45	22	CL		
789	601-1	Drain borings 100' DS 3+00 ℄ Dam S. Bag	1-3'	CL	43 55 64 76 80	85 86 81 82 86 89	91 95 100	39	19	CL		5
790	601-2	" " S. Bag	3-5'	CL	14 20 33 46 47	48 51 53 54 59 66	75 80 83 95 100	37	15	CC		9
791	601-3	" " S. Bag	5-10'	CL-GC	15 19 28 34 37	38 41 43 46 53 57	69 77 90 98 100	40	23	GC		6
792	602-1	Drain Borings 100' DS 4+00 ℄ Dam S. Bag	1-4'	CL-ML	27 42 78 100			43	24	CL		7
793	602-2	" " S. Bag	4-7'	CL-ML	20 29 52 69 78	87 92 93 96 98 81	86 95 97 99 100	35	16	CL		5

Sheet 29 of Appendix B

Form No. 3-275
File Code 580-13-18

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

MISSOURI

Laboratory Sample Number	Field Number	Location and Description	Depth	Field Classification	Mechanical Analysis — Grain Size Distribution Expressed as Percent Finer by Dry Weight: Fines (#200 0.074, #270 0.053, 0.02, 0.005, 0.002)	Sand (#40 0.42, #60 0.25, #100 0.149, #140 0.105, #200 0.074)	Gravel (3/8" 9.52, 1/2" 12.7, 3/4" 19.0, 1" 25.4, 1 1/2" 38.1, 2" 50.8)	Atterberg Limits: L.L.	P.I.	Unified Classification	Sieve Analysis %	Dispersion %	Moisture-Density: Max. Dry Density	Optimum Moisture %
794	201-	Emer. Spwy. 50' rt. of 3+00 L. Bag	3-5'	CL	1 2 5 7 7	7 7 8 9 12 18	27 33 44 54 69 86	29	5	ML				
						26	31 48 64 88 100	Gradation for reference						
795	201-2	" " L. Bag	4.5-7.5'	CL	16 13 17 21 21	22 23 25 26 31	35 39 41 49 58 75	34	14	CL				
796	101-2	Borrow, A 2+25 L. Bag	3-8'	CL-CC	14 21 30 40 40	41 46 49 54 61 72	83 88 94 97 100	36	16	CL				
		Flood plain, peal area						DRY DENSITY = NO. 1				NL	121.5	
797	101-3	" " L. Bag	8-11'	CL	55 42 44 52 53	54 59 59 62 65 77	84 92 95 100	54	32	CL				
		Flood plain, peal area												
798	104-	Borrow, B 7+00 L. Bag	2-7'	CL	18 24 37 39 41	50 58 61 69 78 88	93 99 100	32	14	CL		3		
		Mica abundant, peal area						DRY DENSITY = NO. 4				(2)	91.3	
799	104-2	L. Bag	7-13	CL										

Sheet 30 of Appendix B

SCS-ENG-355A (Rev. 3-70)
FILE CODE ENG-22

LABORATORY NO [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST

PROJECT and STATE: LOST CREEK SITE 5-1, MISSOURI
SAMPLE LOCATION: [illegible]

FIELD SAMPLE NO: 2-1
DEPTH: 4 - 5.5'
GEOLOGIC ORIGIN:

TYPE OF SAMPLE: UNDISTURBED
TESTED AT: SOIL-LINCOLN
APPROVED BY:
DATE:

INDEX TEST DATA

USCS CL ; LL 36 ; PI 14
% FINER (mm): 0.002 ____ ; 0.005 ____ ;
0.074 (#200) ____
G_s (-#4) 2.62 ; G_s (+#4) ____
STANDARD: γ_d MAX. ____ pcf ; w_o ____ %
MODIFIED: γ_d MAX. ____ pcf ; w_o ____ %

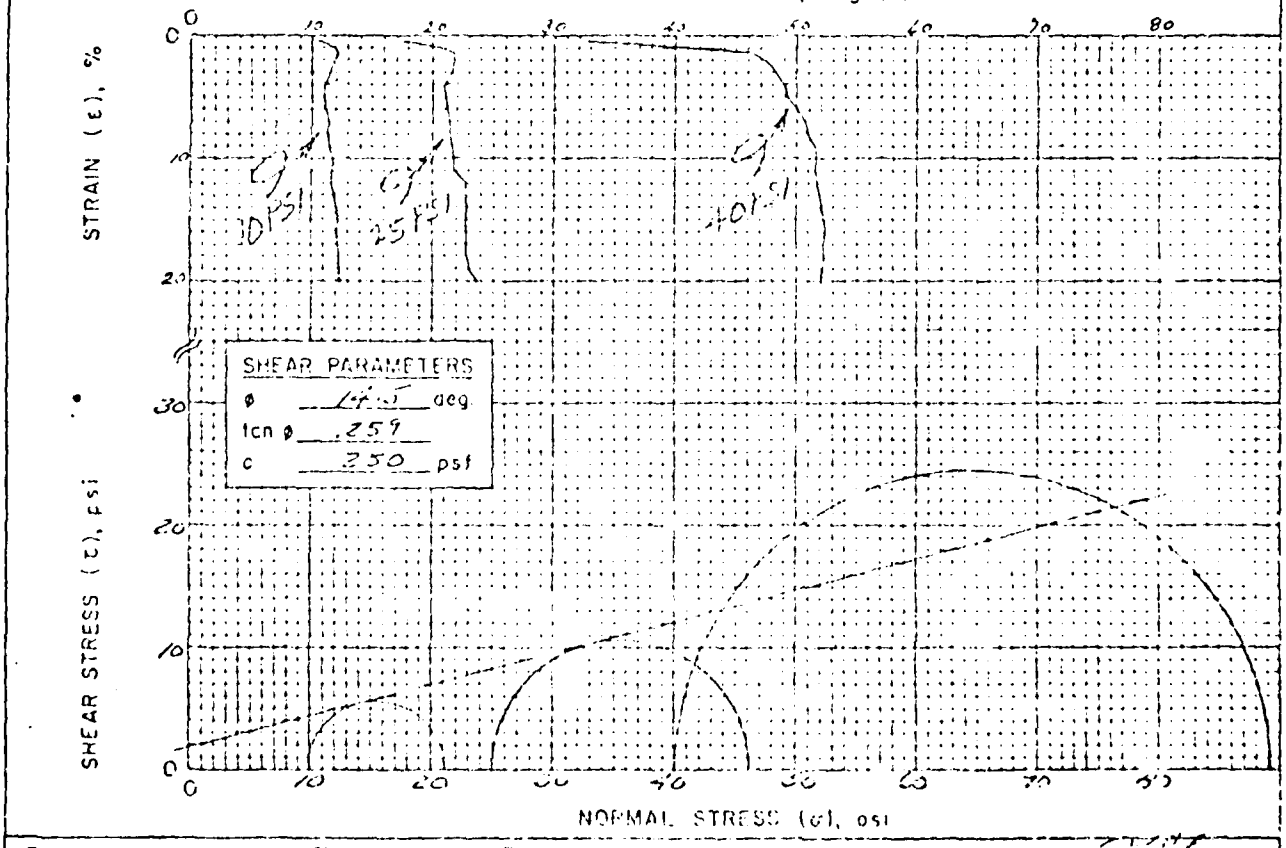
SPECIMEN DATA

HEIGHT 3.0 " ; DIAMETER 1.2 "
MATERIALS TESTED PASSED #40 SIEVE
METHOD OF PREPARATION REMOLDED
FROM UNDISTURBED CORE
MOLDING MOISTURE ____ %
MOLDED AT ____ % OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☐
$\overline{CU}$ ☑
CD ☐

DRY DENSITY INITIAL pcf ☐ g/cc ☒	DRY DENSITY CONSOLIDATED pcf ☐ g/cc ☐	B, Pressure	MOISTURE CONTENT, % START OF TEST	MOISTURE CONTENT, % DEG. OF SAT. AT START OF TEST	MOISTURE CONTENT, % END OF TEST	TIME OF CONSOLIDATION (hrs)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
1.53		0.96			26.4	16.17	10	11.1	4.0
1.54		0.96			25.0	16.08	25	31.0	2.0
1.60		0.96			22.4	16.52	40	49.0	4.0



REMARKS BACK-PRESSURED

Sheet 31 of Appendix B

SCS-ENG-371316-211
FILE CODE ENG-32

T-1

LABORATORY NO. [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST with pore pressure measured

PROJECT and STATE: [illegible] Creek Site E-1, Nebraska

SAMPLE LOCATION: 8 Dam, 1+98 8 Dam

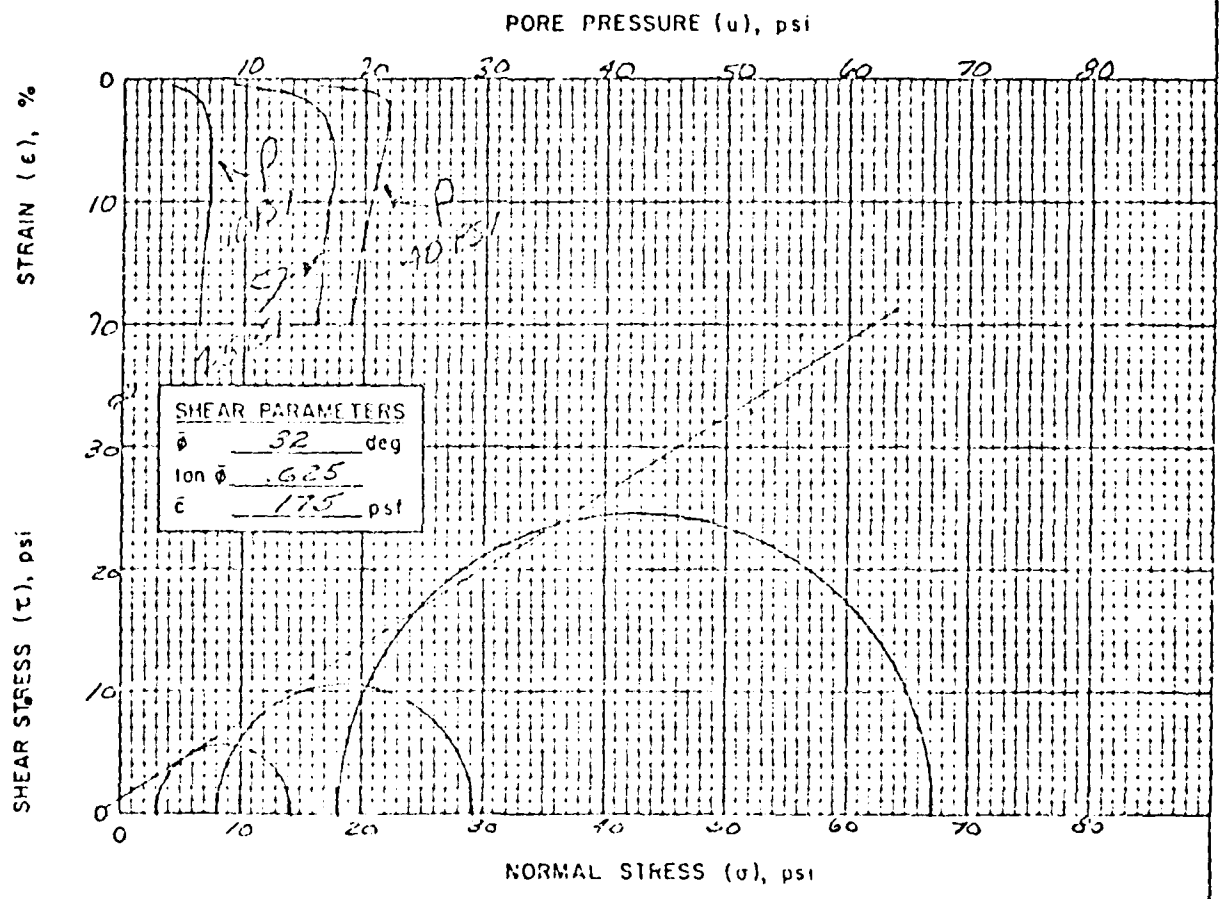
TYPE OF SAMPLE: [illegible]

TESTED AT: [illegible]-Lincoln

APPROVED BY:

DATE:

MINOR PRINCIPAL STRESS, σ_3 (psi)	PORE PRESSURE, u (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, ϵ (%)
10	7.0	3.0	11.1		4.0
25	16.9	8.1	21.0		4.0
40	21.9	18.1	49.0		4.0



REMARKS: BACK-PRESSURED

GTH
8/28

SCS-ENG-155A (Rev. 3-70)
FILE CODE ENG-22

T-2

LABORATORY NO 74-1295

MATERIALS TESTING REPORT	U.S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST

PROJECT and STATE: Lost Creek Site E-1, Wyoming
SAMPLE LOCATION: Boring 1126 ft. Dam

FIELD SAMPLE NO	DEPTH	GEOLOGIC ORIGIN
2-1	4 - 5.5'	

TYPE OF SAMPLE	TESTED AT	APPROVED BY	DATE
UNDISTURBED	SCS-Lincoln		

INDEX TEST DATA

USCS CL ; LL 36 ; PI 14
% FINER (mm): 0.002 23 ; 0.005 31 ;
0.074 (# 200) 85
G_s (-#4) 2.62 ; G_s (+#4) _____
STANDARD: γ_d MAX. _____ pcf; w_o _____ %
MODIFIED: γ_d MAX. _____ pcf; w_o _____ %

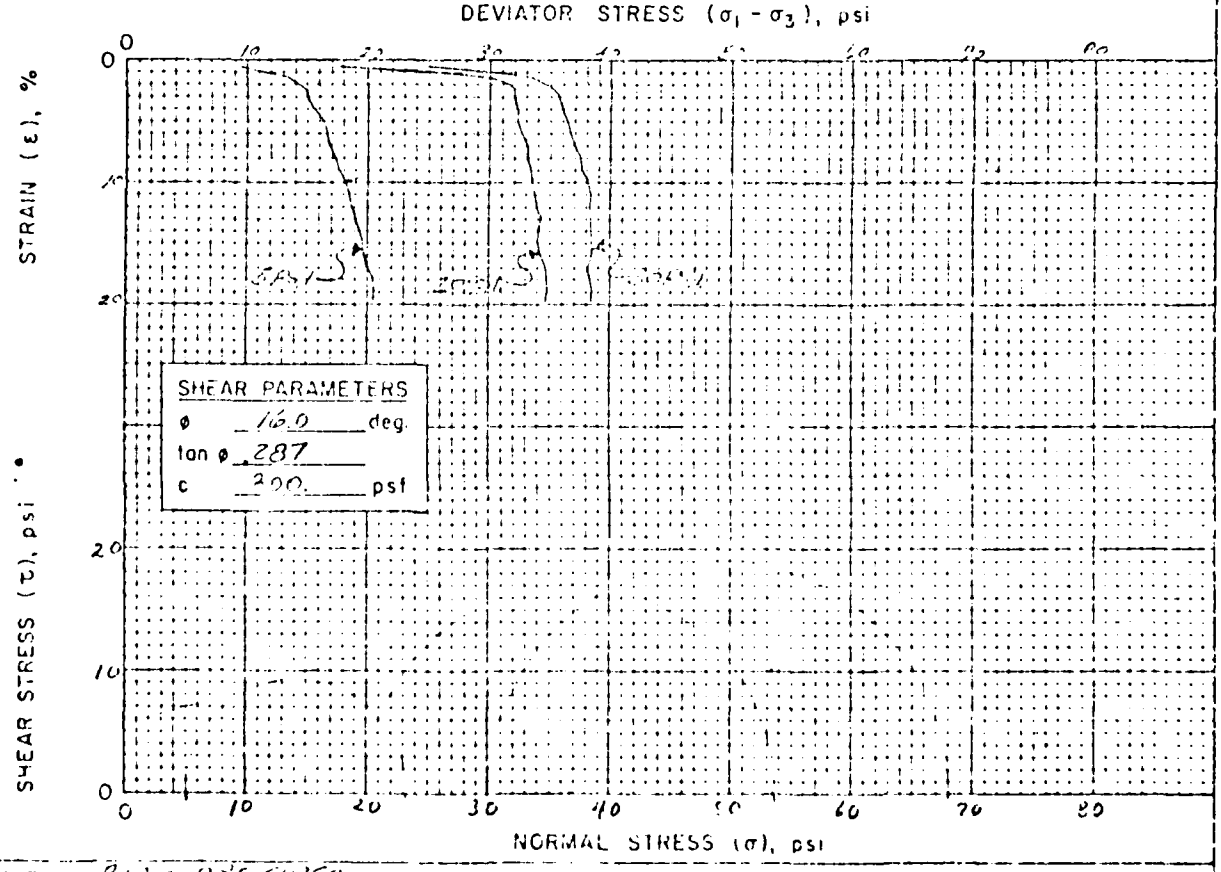
SPECIMEN DATA

HEIGHT 5.0 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED #4 SIEVE
METHOD OF PREPARATION Trimmed from undisturbed core
MOLDING MOISTURE _____ %
MOLDED AT ____ % OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☐
$\overline{CU}$ ☑
CD ☐

DRY DENSITY		B PARAMETER	MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
INITIAL pcf ☐ g/cc ☑	CONSOLIDATED pcf ☐ g/cc ☐		START OF TEST	DEG OF SAT. AT START OF TEST	END OF TEST				
1.59		0.99			25.2	16.23	5	18.1	1.9
1.65		0.95			22.7	16.08	20	33.4	4.3
1.63		0.96			22.6	16.45	50	38.0	4.5



REMARKS Back-pressured

Sheet 33 of Appendix B

SCS ENG-355A(6-71)

LABORATORY NO. 76[illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST with pore pressure measured

PROJECT and STATE: [illegible] Site [illegible], Missouri

SAMPLE LOCATION: F Dam, 1+7[illegible] Dam

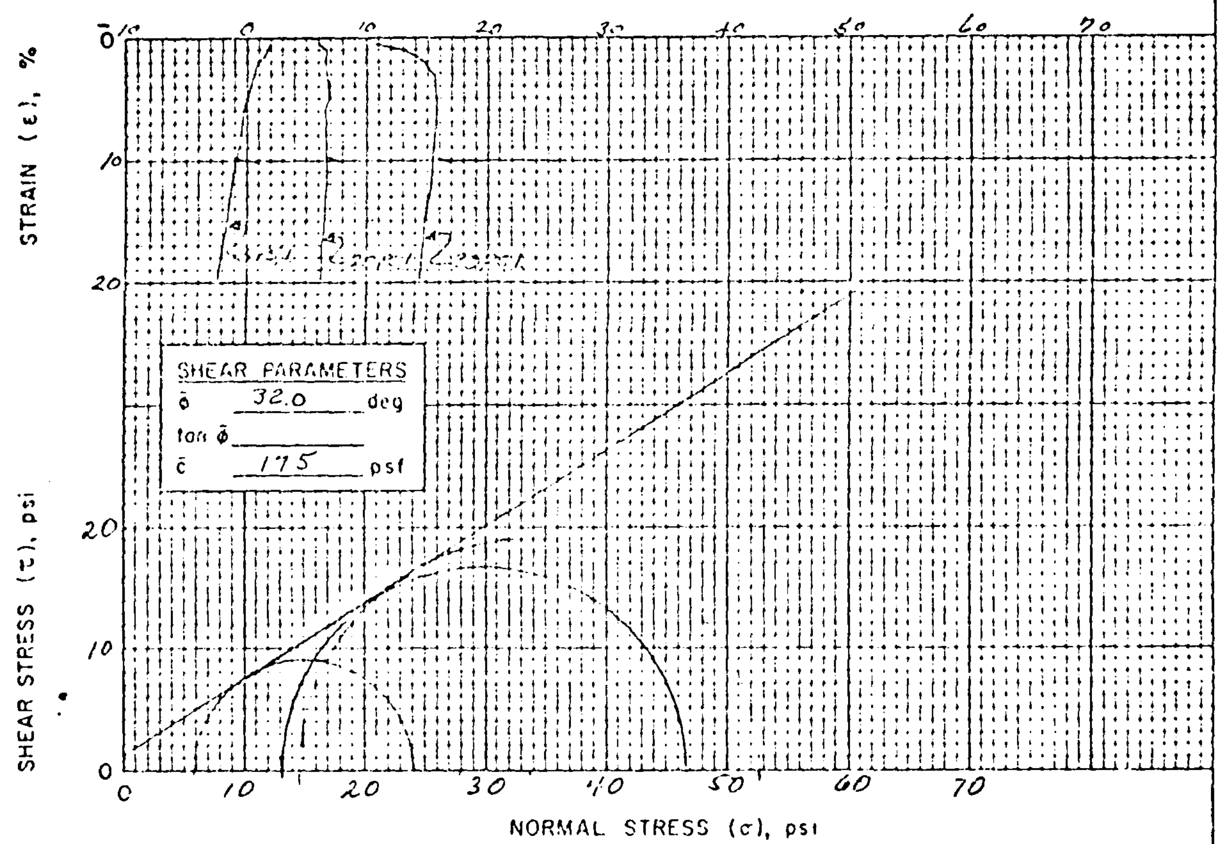
TYPE OF SAMPLE: Undisturbed

TESTED AT: Soil - Lincoln

APPROVED BY:

DATE:

MINOR PRINCIPAL STRESS, σ_3 (psi)	PORE PRESSURE, u (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, ε (%)
5	-0.9	5.9	18.1		9.9
20	+6.7	13.3	33.4		9.9
30	+15.4	14.6	38.0		9.9



REMARKS: BACK - PRESSURED

/RJH

SCS-ENG-155A (Rev. 3-70)
FILE CODE (No. 22)

Composite T-1 & T-2
LABORATORY NO 76W78

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST

PROJECT and STATE: Lost Cr. E-1, MO
SAMPLE LOCATION: E dam Sta 1+98
FIELD SAMPLE NO: 2-1
DEPTH: 4.-5.5'
GEOLOGIC ORIGIN:
TYPE OF SAMPLE: Undisturbed
TESTED AT: SML
APPROVED BY:
DATE: 2/13/76

INDEX TEST DATA

USCS CL ; LL 36 ; PI 14
% FINER (mm): 0.002 23 , 0.005 31 ;
0.074 (# 200) 85
G_s (-#4) 2.62 ; G_s (+#4) _____
STANDARD: γ_d MAX. _____ pcf; w_o _____ %
MODIFIED: γ_d MAX. _____ pcf; w_o _____ %

SPECIMEN DATA

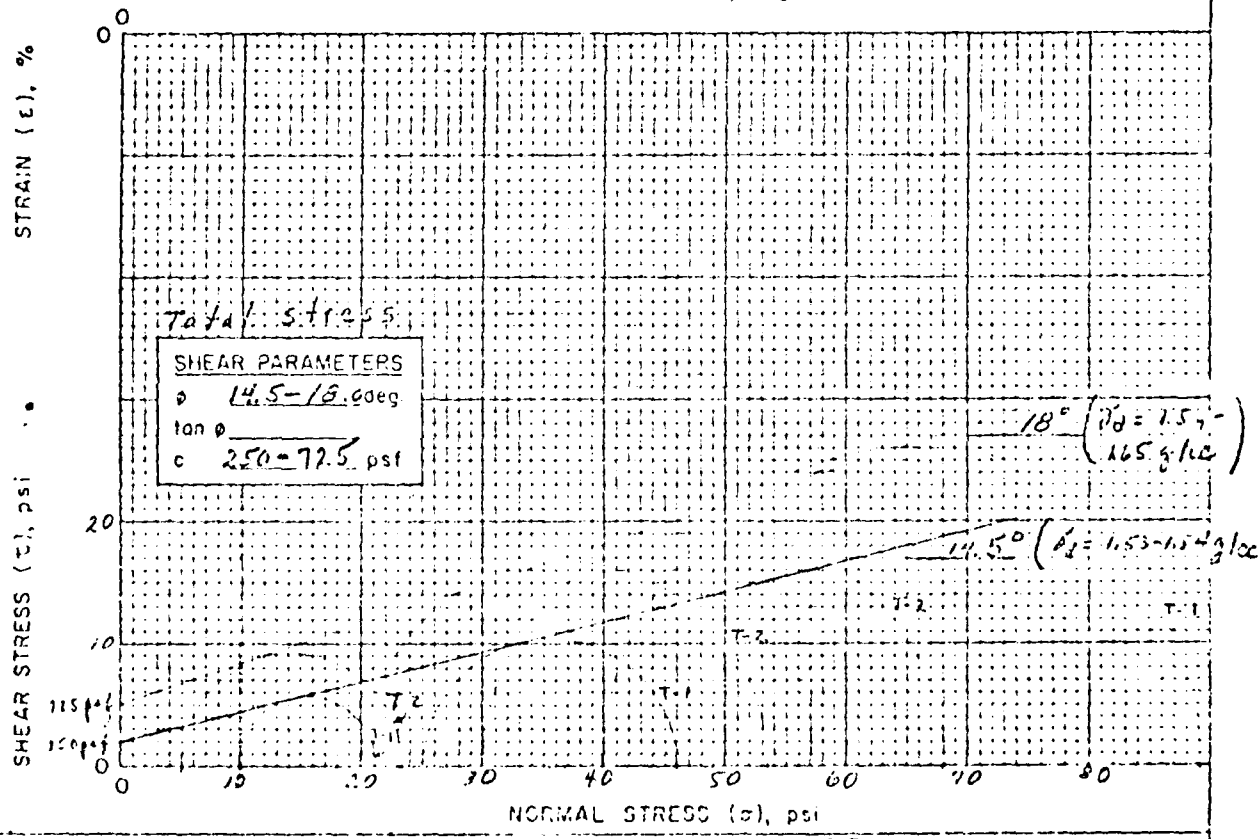
HEIGHT 3.0 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED # 4 SIEVE
METHOD OF PREPARATION Trimmed from an undisturbed core
MOLDING MOISTURE _____ %
MOLDED AT _____ % OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☐
$\overline{CU}$ ☒
CD ☐

DRY DENSITY		B	MOISTURE CONTENT, %			TIME OF CONSOLI-DATION (hrs)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
INITIAL pcf ☐ g/cc ☐	CONSOLI-DATED pcf ☐ g/cc ☐	Parameter	START OF TEST	DEG OF SAT. AT START OF TEST	END OF TEST				
1.53		0.96			26.4	16.17	10	11.1	4.0
1.54		0.96			25.0	16.08	25	21.0	4.0
1.60		0.96			22.4	16.52	40	49.0 (2)	4.0 (2)
1.59		0.97			25.2	16.23	5	18.1	9.9
1.65		0.95			22.7	16.08	20	33.1	9.9
1.63		0.96			24.6	16.05	30	38.0	9.9

DEVIATOR STRESS ($\sigma_1 - \sigma_3$), psi



REMARKS Composite Mohr envelopes from two $\overline{CU}$ triaxial tests.
Sample appears to consist of two materials.

SCS-ENG-355A (Rev. 3-70)
FILE CODE ENG-22

LABORATORY NO. [illegible]

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST

PROJECT and STATE: [illegible] SITE E-1, [illegible] | SAMPLE LOCATION: BOTTOM, A 24+25

FIELD SAMPLE NO: [illegible] | DEPTH: 3-8' | GEOLOGIC ORIGIN:

TYPE OF SAMPLE: [illegible] | TESTED AT: SOIL LINCOLN | APPROVED BY: | DATE:

INDEX TEST DATA

USCS SC ; LL 36 ; PI 16
% FINER (mm): 0.002 14 ; 0.005 21 ;
0.074 (#200) 45
G_s (-#4) 2.65 ; G_s (+#4)
STANDARD: γ_d MAX. 112.5 pcf; w_o 14.0 %
MODIFIED: γ_d MAX. pcf; w_o %

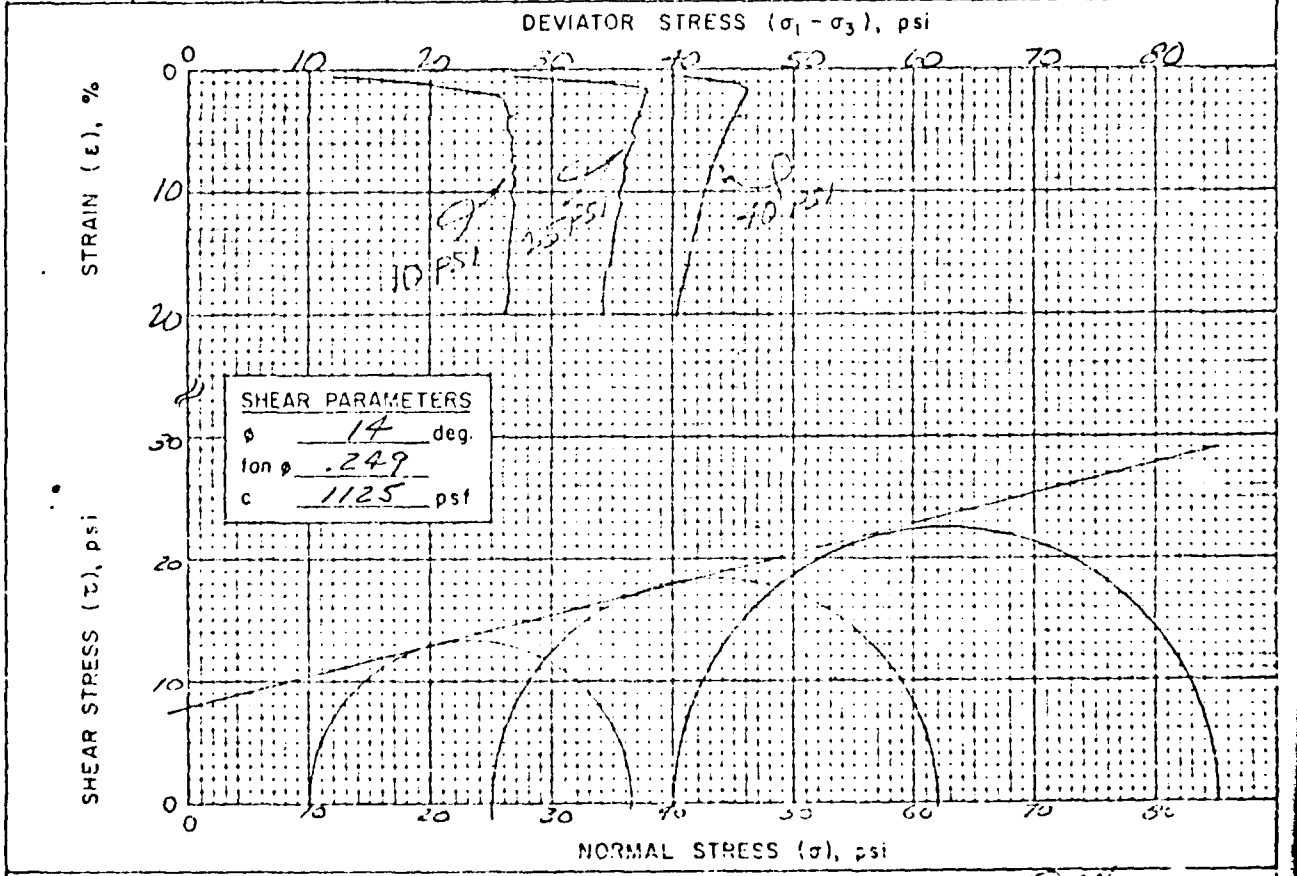
SPECIMEN DATA

HEIGHT 2.0 "; DIAMETER 1.4 "
MATERIALS TESTED PASSED #4 SIEVE
METHOD OF PREPARATION STATIC
[illegible]
MOLDING MOISTURE 17.8 %
MOLDED AT 95.0% OF γ_d MAXIMUM

TYPE OF TEST

UU ☐
CU ☐
$\overline{CU}$ ☑
CD ☐

DRY DENSITY		B, Parameter	MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ε (%)
INITIAL pcf ☒ g/cc ☐	CONSOLIDATED pcf ☐ g/cc ☐		START OF TEST	DEG. OF SAT AT START OF TEST	END OF TEST				
106.9		0.94			20.5	16.18	10	26.5	4.0
106.8		0.98			20.0	16.50	25	36.9	4.0
107.0		0.96			19.5	15.23	40	45.0	4.0



REMARKS BACK-PRESSURED

GVT

Sheet 36 of Appendix B

SCS-ENG-355816-711
FILE CODE ENG-22

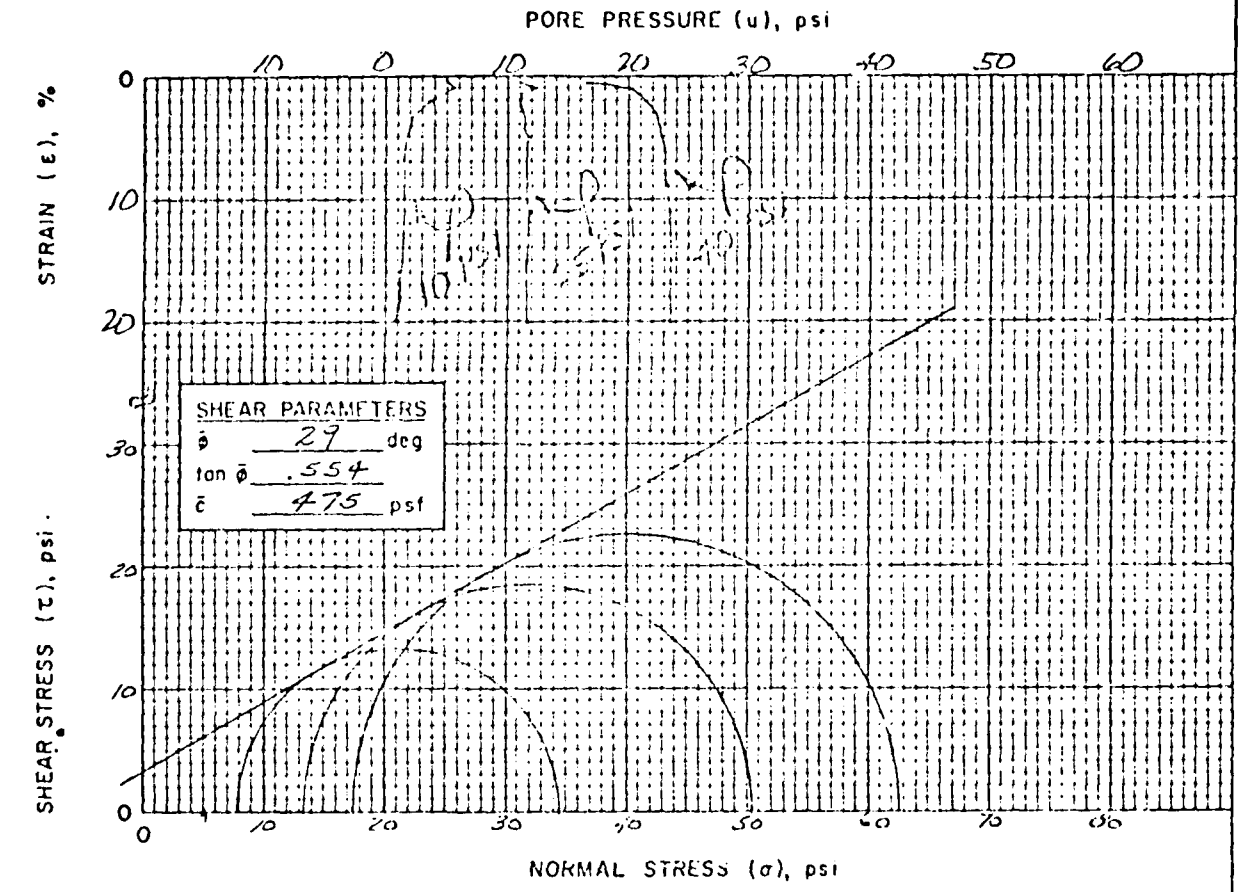
LABORATORY NO 76141296

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	TRIAXIAL SHEAR TEST with pore pressure measured

PROJECT and STATE: LAST CHANCE CK. STR. E-1, MISSOURI — SAMPLE LOCATION: BOREHOLE A 2+25

TYPE OF SAMPLE: UNDISTURBED — TESTED AT: SOIL-LINCOLN — APPROVED BY: — DATE:

MINOR PRINCIPAL STRESS, σ_3 (psi)	PORE PRESSURE, u (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, ε (%)
10	2.1	7.9	26.5		4.0
25	11.6	13.4	36.9		4.0
40	22.5	17.5	45.0		4.0



REMARKS: BACK-PRESSURED

GTH/EDB

SCS-ENG-352 (REV. 3-70)
FILE CODE ENG-3

LABORATORY NO 76W796

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT and STATE: Lost Creek #E-1, Missouri.

FIELD SAMPLE NO	LOCATION	DEPTH
101-2	Borrow A 2+25	3-8'

GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	SML-LINCOLN		

CLASSIFICATION SC LL 36 PI 16

MAX. PARTICLE SIZE INCLUDED IN TEST < 3/4 "

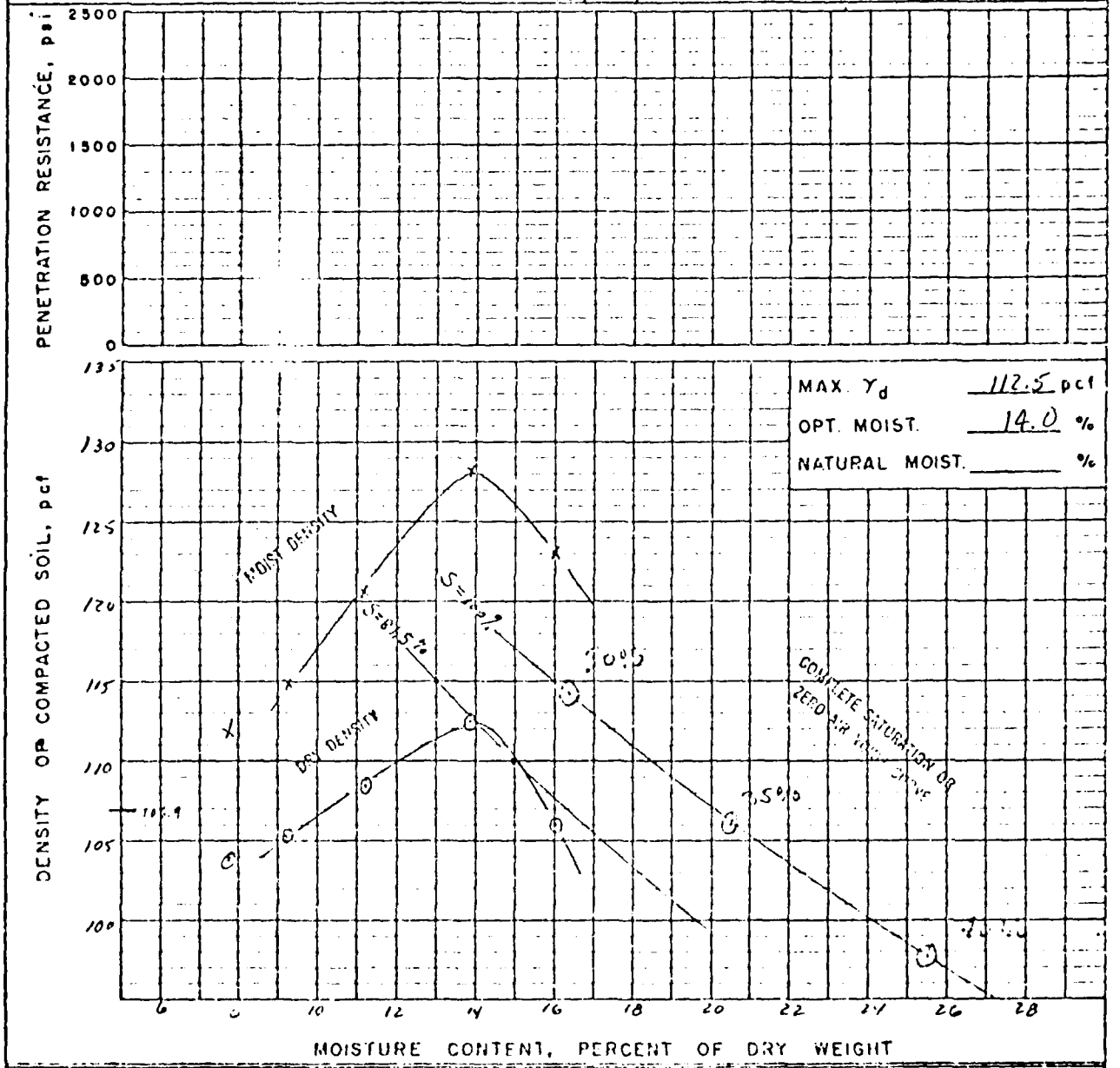
SPECIFIC GRAVITY (G_s) { MINUS NO 4 2.65; PLUS NO. 4 2.47; AV. 2.61

CURVE NO. 1X OF 2

STD (ASTM D-698) ☑; METHOD C

MOD (ASTM D-1557) ☐; METHOD

OTHER TEST ☐ (SEE REMARKS)



REMARKS

CURVE IS FOR THE MINUS NO. 4 FRACTION

GRADATION OF TOTAL SAMPLE

< NO. 200 40 %; < NO. 4 72 %; < 1½ IN. 100 %

NCS ENG-392 (REV. 3-70)
FILE COPY (ENG-22)

LABORATORY NO. 76W798

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE

PROJECT and STATE: Lost Creek #E-1, Missouri

FIELD SAMPLE NO	LOCATION	DEPTH
L04-1	Borrow B 7+00	2-7'

GEOLOGIC ORIGIN	TESTED AT	APPROVED BY	DATE
	SML-LINCOLN		

CLASSIFICATION CL LL 36 PI 16

MAX. PARTICLE SIZE INCLUDED IN TEST #4 "

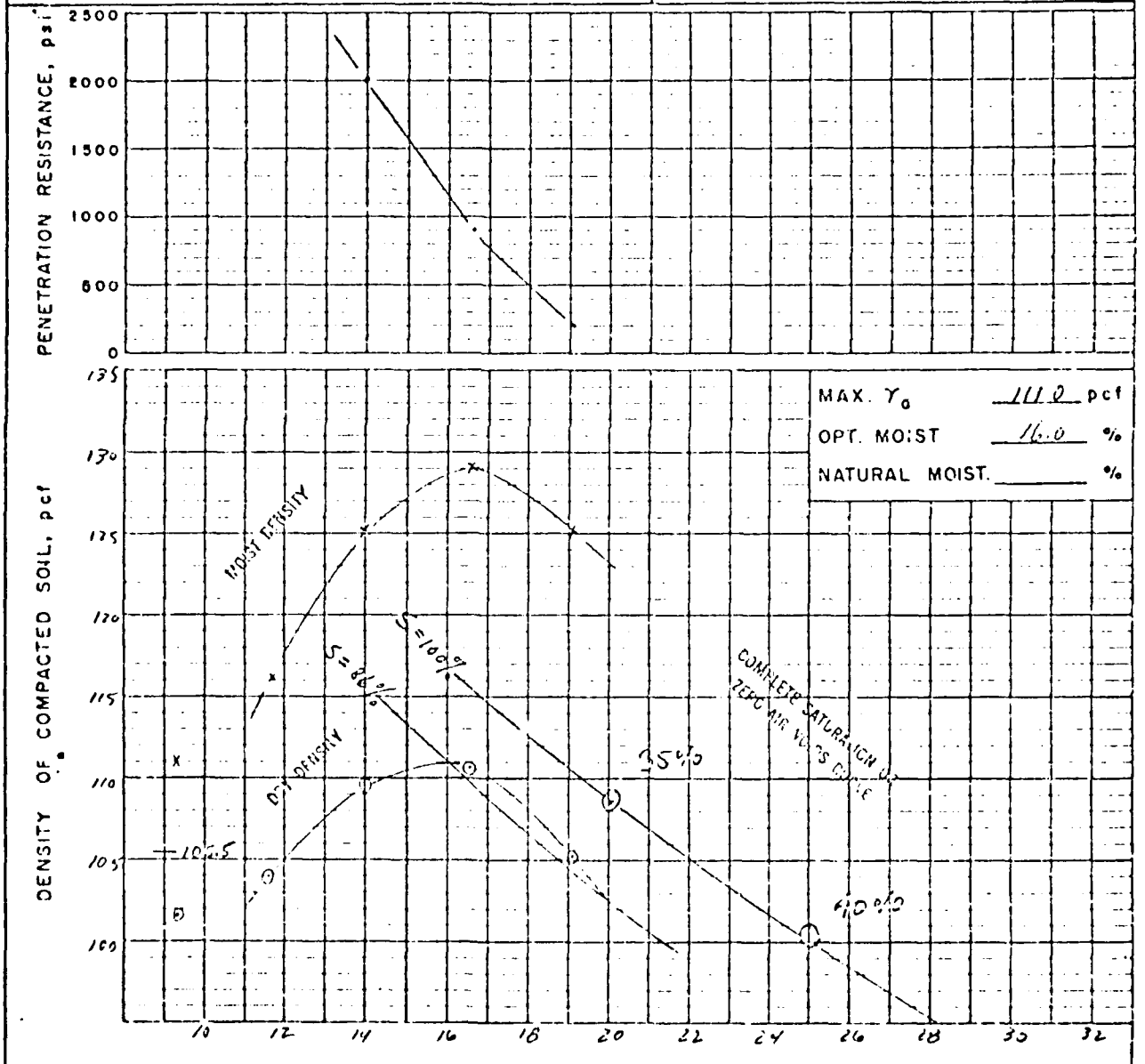
SPECIFIC GRAVITY (G_s) { MINUS NO 4 2.67 ; PLUS NO. 4 2.56

CURVE NO. 2 OF 2

STD (ASTM D-698) ☒; METHOD A

MOD (ASTM D-1557) ☐; METHOD

OTHER TEST ☐ (SEE REMARKS)



REMARKS

CURVE IS FOR THE MINUS NO. 4 FRACTION

GRADATION OF TOTAL SAMPLE

< NO. 200 51 %; < NO. 4 85 %; < 3" IN. 100 %

SCS-ENG-357
REV. 7-71

MATERIALS TESTING REPORT | **U.S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE** | **SUMMARY - SLOPE STABILITY ANALYSIS**

PROJECT and STATE: LOST CREEK #E-1 MISS. 2201
METHOD OF ANALYSIS: ICES
ANALYZED AT: S.M.L., LINCOLN, NE.
APPROVED BY:
DATE: 1-27-76

	SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA: Yd (pcf)	Ym (pcf)	Ysat (pcf)	Ysub (pcf)	ϕ (deg)	tan ϕ	c (psf)	REMARKS
①	Foundation (76W785)	CL	97.5		122.5	60.0	14.5	.259	250	
②							32	.625	175	
③	Embankment (76W796)	SC	102.9	122.0	122.0	66.5	14	.249	1125	
④							29	.554	475	
⑤										
⑥										
⑦										
⑧										

TRIAL NO.	SLOPE	CONDITIONS	F_s BISHOP	F_s SWEDISH CODE
		Upstream - Fulldrawdown Dnstr. - Steady Seepage		
		Maximum Section @ Station 1+30; circular arc anal.		
1Up	2½:1	Embank. (29°-475) & 5' Found. (14.5°-250), 15' berm @ elev. 975.6.	1.43	1.46
2Dn	2½:1	Embank. (29°-475) & 5' Found. (14.5°-250), 10' berm @ elev. 973.3.	1.40	1.41
3Dn	2½:1	Embank. (29°-475) & 5' Found. (14.5°-250), 20' berm @ elev. 973.3.	1.53	1.52
4Dn	2½:1	Embank. (29°-475) & 5' Found. (14.5°-250), 10' berm @ elev. 973.3, Drain @ r_u = 0.6.	1.62	1.58
		Flood Plain Section @ Station 2+65; circular arc anal.		
5Up	2½:1 & 2	Embank. (29°-475) & 12' Found. (14.5°-250), 15' berm @ elev. 975.6.	1.27	1.25
6Up	2½:1 & 2	Embank. (29°-475) & 12' Found. (14.5°-250), 15' berm @ elev. 975.6.	1.35	1.33
5Dn	2½:1	Embank. (29°-475) & 12' Found. (14.5°-250), 10' berm @ elev. 973.3.	1.24	1.22
6Dn	2½:1	Embank. (29°-475) & 12' Found. (14.5°-250), 30' berm @ elev. 973.3.	1.46	1.42
	2½:1	Excavation, 34' berm @ elev. 973.3.	1.50	1.46
7Dn	2½:1	Embank. (29°-475) & 12' Found. (14.5°-250), 10' berm @ elev. 973.3, Drain @ r_u = 0.6.	1.45	1.38
8Dn	2½:1	Embank. (29°-475) & 12' Found. (14.5°-250), 20' berm @ elev. 973.3, Drain @ r_u = 0.6.	1.56	1.49

Sheet 1 of 2

SCS-ENG-357
REV. 7-71

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	SUMMARY - SLOPE STABILITY ANALYSIS

PROJECT and STATE	DATE
LOST CREEK #E-1 MISSOURI	1-29-76

METHOD OF ANALYSIS	ANALYZED AT	APPROVED BY
NAVDOCKS BLOCK	SAIL, LINCOLN, NE.	

SOURCE AND USE OF MATERIALS	CLASSI-FICA-TION	γ_d (pcf.)	γ_m (pcf)	γ_{sat} (pcf)	γ_{sub} (pcf)	ϕ (deg)	tan ϕ	c (psf)	REMARKS
①									
②									
③									
④									
⑤									
⑥									
⑦									
⑧									

TRIAL NO.	SLOPE	CONDITIONS	F_s
		Upstream-Fulldrawdown — Dnstr.-Steady Seepage	
		Navdocks Block Analysis	
		Maximum Section @ Station 1+30	
11Up	[illegible]	Embank.(29°-475) & 5' Found.(14.5°-250), 15' berm @ elev. 975.6.	1.17
12Up	[illegible]	Embank.(29°-475) & 5' Found.(14.5°-250), 30' berm @ elev. 975.6.	1.35
13Dn	2½:1	Embank.(29°-475) & 5' Found.(14.5°-250), 10' berm @ elev. 973.3.	1.16
[illegible]	2½:1	Embank.(29°-425) & 5' Found.(14.5°-250), 35' berm @ elev. 973.3.	1.50
13ADn	2½:1	Embank.(29°-475) & 5' Found.(14.5°-250), 10' berm @ elev. 973.3, Drain @ c/b = 0.6.	1.39
15Dn	2½:1	Same conditions as trial #13A except 50' berm @ elev. 973.3.	1.50
		Flood Plain Section @ Station 2+65	
16Up	3½/3:1	Embank.(29°-475) & 3' Found.(14.5°-250), 15' berm @ elev. 975.6.	1.27
17Up	3½/3:1	Embank.(29°-475) & 3' Found.(14.5°-250), 32' berm @ elev. 975.6.	1.35
18Dn	2½:1	Embank.(29°-475) & 3' Found.(14.5°-250), 10' berm @ elev. 973.3.	1.27
19Dn	2½:1	Embank.(29°-475) & 3' Found.(14.5°-250), 63' berm @ elev. 973.3.	1.50
18ADn	2½:1	Embank.(29°-475) & 3' Found.(14.5°-250), 10' berm @ elev. 973.3, Drain @ c/b = 0.6.	1.35
20Dn	2½:1	Embank.(29°-475) & 3' Found.(14.5°-250), 36' berm @ elev. 973.3, Drain @ c/b = 0.6.	1.50
		Maximum Section @ Sta. 1+30	
11AUp	3½/3:1	Same conditions as trial #11 except 5' Found.(15°-725)	1.72
13BDn	2½:1	Same conditions as trial #13A except 5' Found.(15°-725)	1.93

FOR FILE DATA

160'

515

ENGINEERING GEOLOGIC REPORT ON SCS E-1 LAKE SITE

NEWTON COUNTY, MISSOURI

LOCATION: NE¼, SW¼, NE¼, Sec. 16, T. 25 N., R. 34 W., Racine Quadrangle.

Dam was under construction on 26 October 1978. Core trench had been cut into weathered residual chert faulted and fractured. Locally, pinnacles are massive Burlington limestone where exposed particularly in the emergency spillway. However, the abutments were mainly of fractured chert both as loose rock fragments and as massive chert ledges.

Numerous springs were present in the valley floor at and upstream of the dam site. The valley is a gaining valley. Construction procedures included the placement of drainage facilities and collection of water from the springs for discharge downstream of the dam. Persons present during the inspection were Neil Randall, Soil Conservation Service, Columbia, Mo., and Don Hixson, Soil Conservation Service, Lincoln, Nebraska.

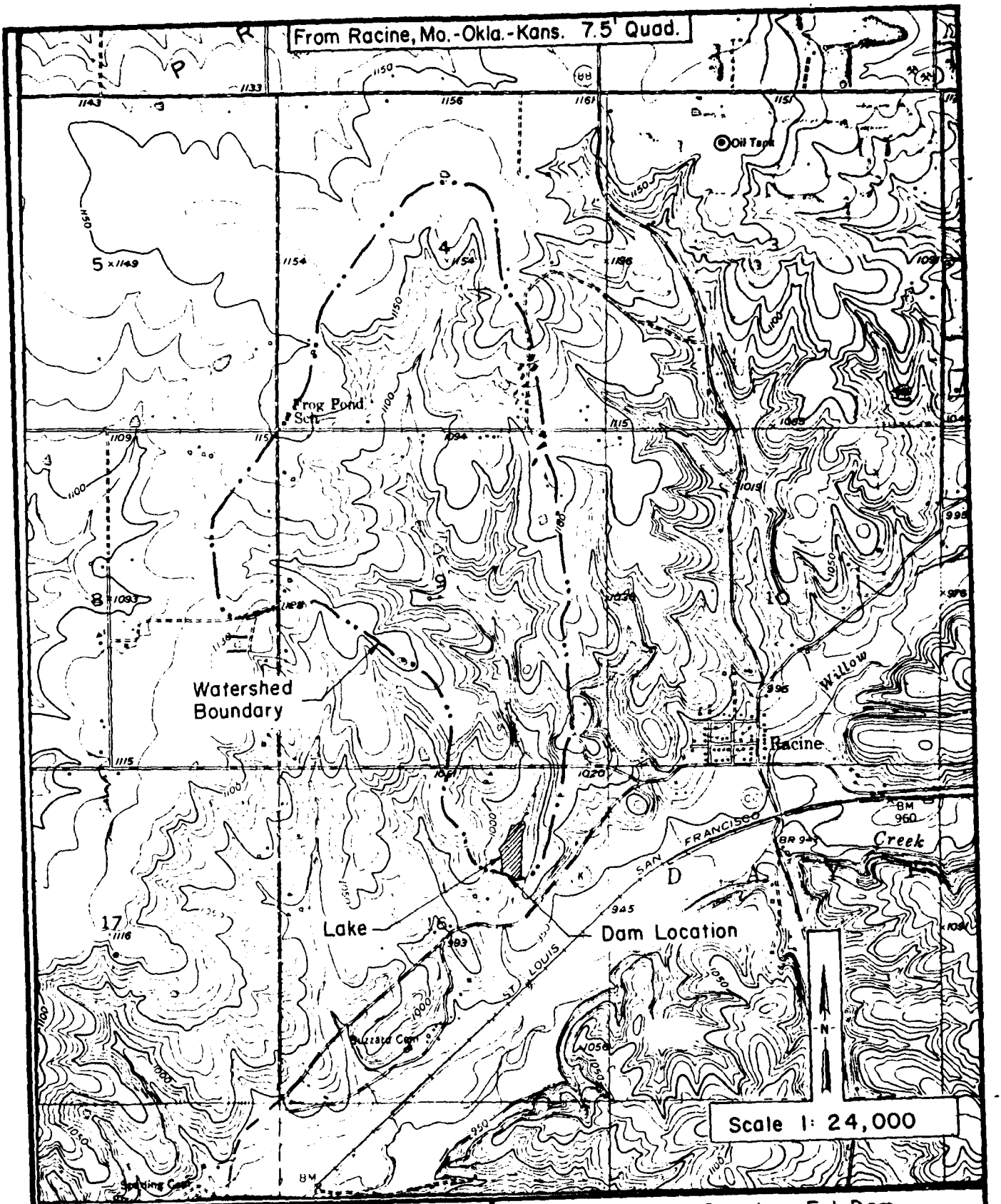
Dr. J. Hadley Williams, Chief
Engineering Geology Section
Geology & Land Survey
October 27, 1978

APPENDIX C

Overtopping Analysis

AD-A105 102 ANDERSON ENGINEERING INC SPRINGFIELD MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. STRUCTURE E-1 (MO 20511), VERDIGRI--ETC(U)
AUG 80 J HEALY, S BRADY, N MORALES, T BECKLEY DACW43-80-C-0073
UNCLASSIFIED NL

END
DATE FILMED
0 81
DTIC



LAKE AND WATERSHED MAP

HANSON ENGINEERS

SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Newton County Structure E-1 Dam
Newton County, Missouri
Mo. I.D. No. 20511

Sheet 1, Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination).

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The parameters for the unit hydrograph are shown in Table 1 (Sheet 4, Appendix C).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2 (Sheet 5, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method. The hydraulic capacity of the spillway was used as an outlet control in the routing. The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation-surface area-storage-discharge relationships shown in Table 3 (Sheet 5, Appendix C). This dam has been designed for flood control purposes, and the water surface elevation is maintained below the primary spillway invert elevation. To consider the effect of the reservoir storage, an antecedent storm of 25 percent and 50 percent of the PMF was considered (assuming the reservoir at the sedimentation pool elevation 975.6) to determine the starting reservoir elevation for the routing of 50 percent and 100 percent of the PMF respectively. The antecedent storms were assumed to occur four days prior to their corresponding storm. Both antecedent storms will fill the reservoir beyond the emergency spillway level, but at the end of the four days, the level of the reservoir will reduce to elevation 975.6 since the primary spillway is unregulated. Thus, the final routing analysis was accomplished considering the starting reservoir level at elevation 975.6.

The result of the routings of the PMF ratios indicate that the dam will pass the 1 percent probability flood without overtopping the dam.

The rating curve for the spillways (see Table 4 Sheet 6, Appendix C) was determined assuming orifice flow for the primary spillway and channel flow for the emergency spillway.

The flow over the crest of the dam during overtopping was determined using the non-level dam option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 7, Appendix C).

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF are presented on Sheets 8, 9 and 10 of Appendix C.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	1.15 sq. miles
Length of Watercourse (L)	2.08 miles
Difference in elevation (H)	190 feet
Time of concentration (Tc)	0.80 hours
Lag Time (Lg)	0.48 hours
Time to peak (Tp)	0.565 hours
Peak Discharge (Qp)	985 c.f.s.
Duration (D)	10 min.

Time (Min.)(*)	Discharge (cfs)(*)
0	0
10	183
20	634
30	967
40	925
50	690
60	401
70	250
80	154
90	96
100	59
110	36
120	23
130	14
140	9
150	6
160	3

(*) From the computer output

FORMULA USED:

$$Tc = \left(\frac{11.9\ L^3}{H} \right)^{0.385}$$

$$Lg = 0.6\ Tc$$

$$Tp = \frac{D}{2} + Lg$$

$$Qp = \frac{484\ A.Q}{Tp} \qquad Q = \text{Excess Runoff} = 1 \text{ inch}$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	35.5	33.7	1.8

Additional Data:

1) Soil Conservation Service Soil Group B
2) Soil Conservation Service Runoff Curve CN = 86 (AMC III) for the PMF
3) Soil Conservation Service Runoff Curve CN = 71 (AMC II) for the 1 percent probability flood
4) Percentage of Drainage Basin Impervious 5 percent

TABLE 3

ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
960.0	0	0	
* 975.6	9.5	60	0
980.0	11.3	106	26
984.0	16.6	165	37
990.0	24.0	285	49
996.4	31.5	465	59
1000.0	36.3	590	1564
** 1002.9	41.5	700	4918
1005.0	43.3	790	7970
1010.0	50.3	1020	--

*Primary spillway crest elevation
**Top of dam elevation

The above relationships were developed using data from the SCS plans and the U.S.G.S. SENECA, MO.-OKLA. 7.5 minute quadrangle map.

TABLE 4

SPILLWAYS RATING CURVE

Reservoir Elevation (Ft MSL)	Primary Spillway (c.f.s.)	Emergency Spillway (c.f.s.)	Total Discharge (c.f.s.)
975.16	0		0
980.0	26		26
984.0	37		37
990.0	49		49
996.4	59	0	59
996.9	60	56	116
997.4	61	188	249
997.9	61	374	435
998.4	62	610	672
999.4	63	1250	1313
1000.4	65	2060	2125
1001.4	66	3080	3146
1002.4	67	4220	4287
* 1002.9	68	4850	4918
1003.4	69	5500	5569
1004.4	70	6980	7050
1005.4	71	8560	8631
1006.4	72	10300	10372

* Top of Dam Elevation

METHOD USED:

1) Primary Spillway: Assuming orifice flow

$Q = C.A. (2\ g.h)^{1/2}$

Q = Discharge in c.f.s.
C = Discharge coefficient = 0.60
A = Opening area in ft^2 (14" x 28")
g = Acceleration of gravity = 32.2 ft/sec^2
h = Head measured from reservoir elevation to center of orifice (in ft)

2) Emergency Spillway: Assuming open channel flow

Using charts from "UD Method of Reservoir Flood Routing," S.C.S. Technical Release No. 35, February 1967.

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
	0	* 975.6	60	26	
	0	** 984.0	165	37	
0.20	1756	997.1	488	157	
0.30	2634	998.9	550	967	
0.40	3512	1000.4	604	2096	
0.50	4390	1001.4	644	3166	
0.60	5268	1002.2	674	4074	
0.70	6147	*** 1002.9	699	4898	0
0.80	7025	1003.5	723	5658	0.6
0.90	7903	1003.9	745	6534	1.0
1.00	8781	1004.4	762	7507	1.5

The percentage of the PMF that will reach the top of the dam is 70 percent.

* Primary spillway crest elevation
** Starting reservoir level used for routings
*** Top of dam elevation

PMF RATIOS
INPUT DATA

```
A       OVERTOPPING ANALYSIS FOR NEWTON COUNTY STRUCTURE E-1 DAM ( # 5 )
A       STATE ID NO. 20511  COUNTY NAME : NEWTON
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 80S3001
B    144              10
B1     5
J      1       9       1
J1   .20     .30     .40     .50     .60     .70     .80     .90     1.0
K      0       1                               3       1
K1      INFLOW HYDROGRAPH COMPUTATION **
M      1       2    1.15            1.15       1                       1
P      0    27.3     102     120     130
T                                                   -1     -86             0.05
W2  0.80    0.48
X      0      -.1       2
K      1       2                       0       4       1
K1      RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE **
Y                                       1       1
Y1     1                                                165      -1
Y4 975.6   980.0   984.0   990.0   996.4   996.9   997.4   997.9   998.4   999.4
Y41000.4  1001.4  1002.4  1002.9  1003.4  1004.4  1005.4  1006.4
Y5     0      26      37      49      59     116     249     435     672    1313
Y5  2125    3146    4287    4918    5569    7050    8631   10372
$S     0      60     106     165     285     465     590     700     790    1020
$E 960.0   975.6   980.0   984.0   990.0   996.4  1000.0  1002.9  1005.0  1010.0
$$ 984.0
$D1002.9
$L     0      38      78     215     332     440     620     740     745     750
$V1002.9  1003.4  1003.5  1004.0  1004.2  1004.3  1004.7  1004.8  1005.5  1006.6
K     99
```

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 0.20	RATIO 2 0.30	RATIO 3 0.40	RATIO 4 0.50	RATIO 5 0.60	RATIO 6 0.70	RATIO 7 0.80	RATIO 8 0.90	RATIO 9 1.00
HYDROGRAPH AT	1	1.15	1	1756.	2634.	3512.	4390.	5268.	6147.	7025.	7903.	8781.
	(	2.98)	(	49.73)(	74.59)(	99.46)(	124.32)(	149.19)(	174.05)(	198.91)(	223.78)(	248.64)
ROUTED TO	2	1.15	1	157.	967.	2096.	3166.	4074.	4898.	5658.	6534.	7507.
	(	2.98)	(	4.45)(	27.37)(	59.34)(	89.65)(	115.36)(	138.70)(	160.20)(	185.02)(	212.58)

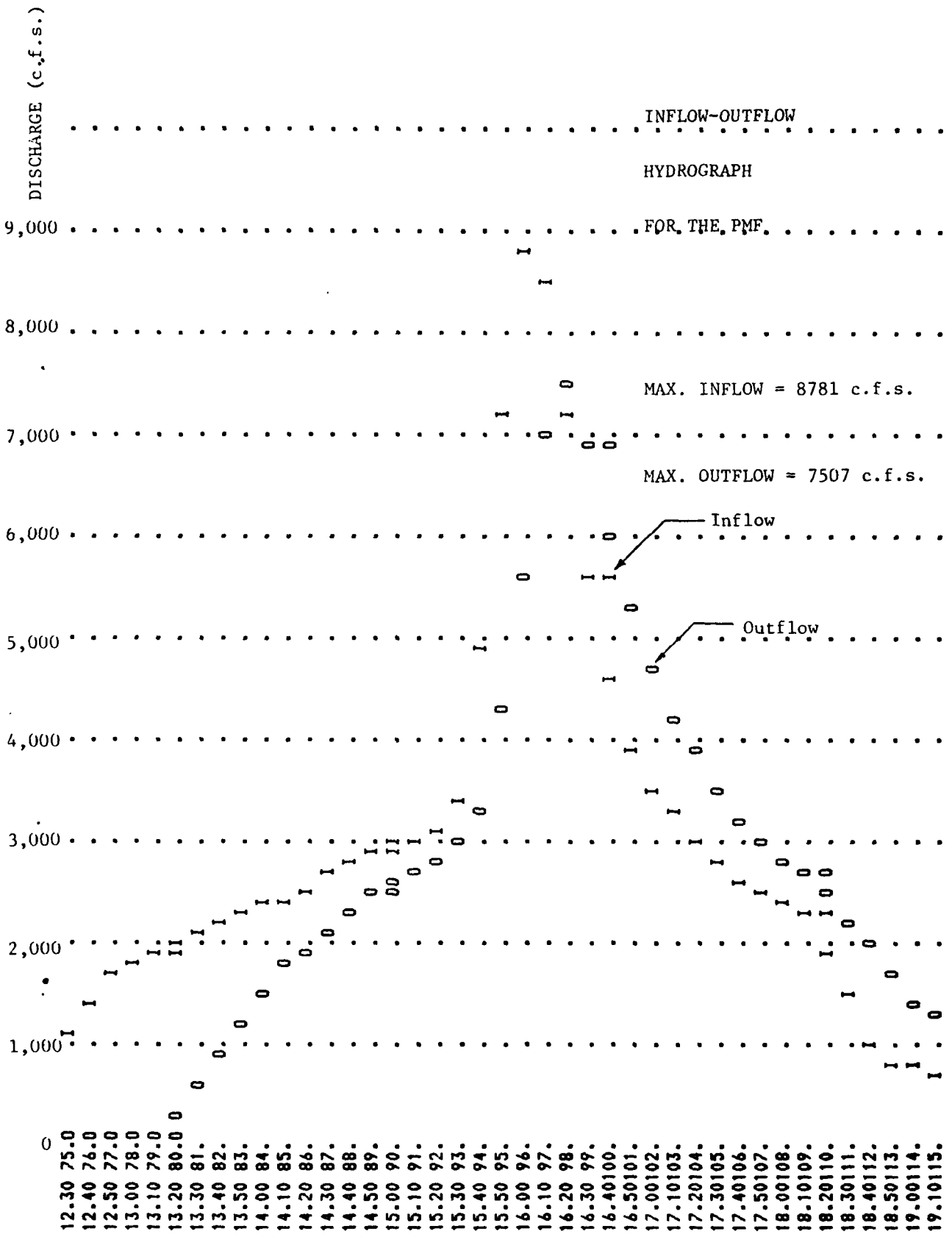
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	984.00	984.00	1002.90
STORAGE	165.	165.	700.
OUTFLOW	37.	37.	4918.

PMF RATIOS
OUTPUT DATA

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.20	997.06	0.00	488.	157.	0.00	19.00	0.00
0.30	998.86	0.00	550.	967.	0.00	17.17	0.00
0.40	1000.36	0.00	604.	2096.	0.00	16.50	0.00
0.50	1001.42	0.00	644.	3166.	0.00	16.50	0.00
0.60	1002.21	0.00	674.	4074.	0.00	16.33	0.00
0.70	1002.88	0.00	699.	4898.	0.00	16.33	0.00
0.80	1003.45	0.55	723.	5658.	0.67	16.33	0.00
0.90	1003.94	1.04	745.	6534.	0.83	16.33	0.00
1.00	1004.36	1.46	762.	7507.	1.00	16.33	0.00


DISCHARGE (c.f.s.)
INFLOW-OUTFLOW
HYDROGRAPH
FOR THE PMF
MAX. INFLOW = 8781 c.f.s.
MAX. OUTFLOW = 7507 c.f.s.
Inflow
Outflow
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
12.30 75.0
12.40 76.0
12.50 77.0
13.00 78.0
13.10 79.0
13.20 80.0
13.30 81.
13.40 82.
13.50 83.
14.00 84.
14.10 85.
14.20 86.
14.30 87.
14.40 88.
14.50 89.
15.00 90.
15.10 91.
15.20 92.
15.30 93.
15.40 94.
15.50 95.
16.00 96.
16.10 97.
16.20 98.
16.30 99.
16.40100.
16.50101.
17.00102.
17.10103.
17.20104.
17.30105.
17.40106.
17.50107.
18.00108.
18.10109.
18.20110.
18.30111.
18.40112.
18.50113.
19.00114.
19.10115.
TIME (hrs.)

APPENDIX D

Photographs

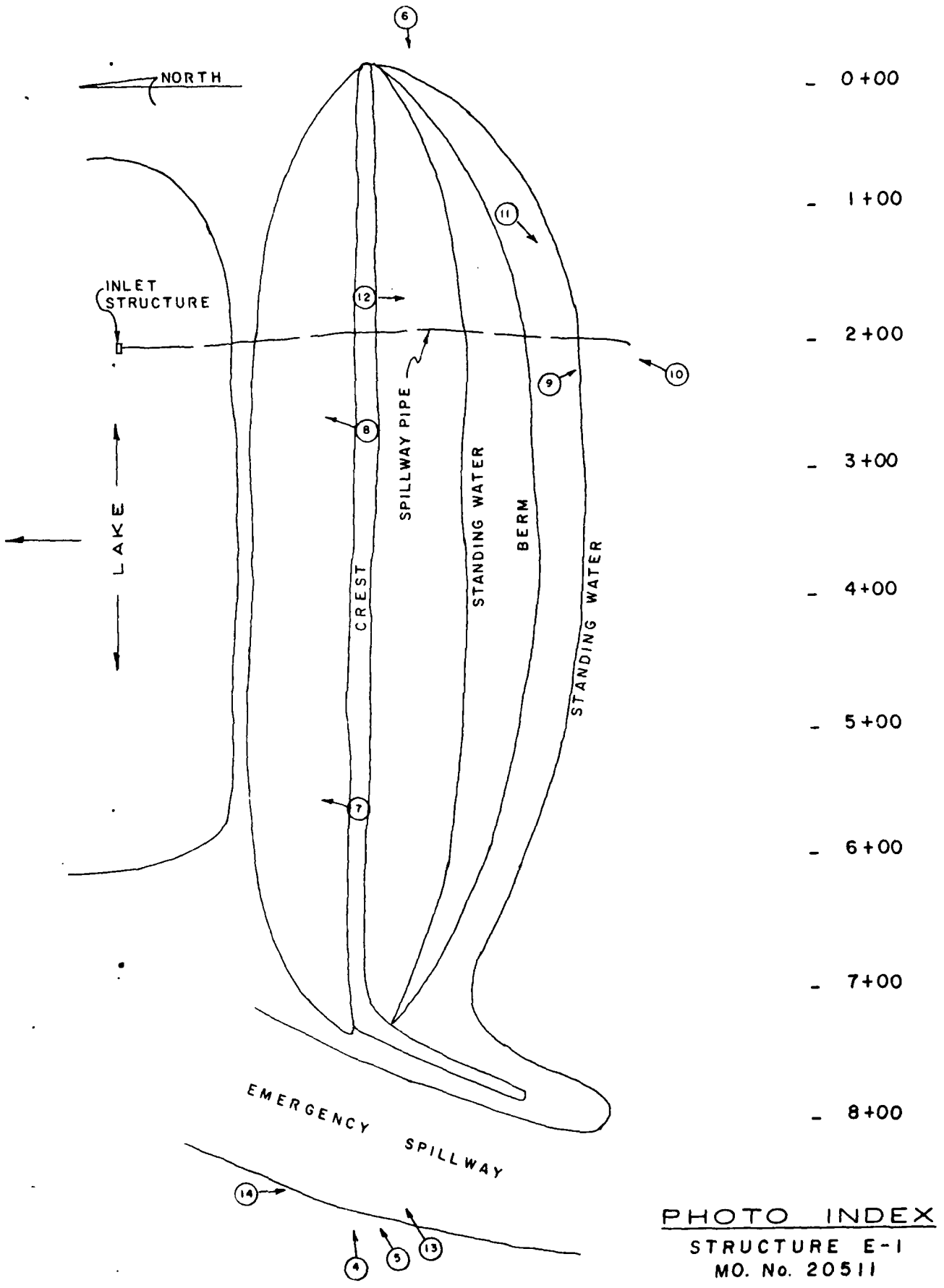
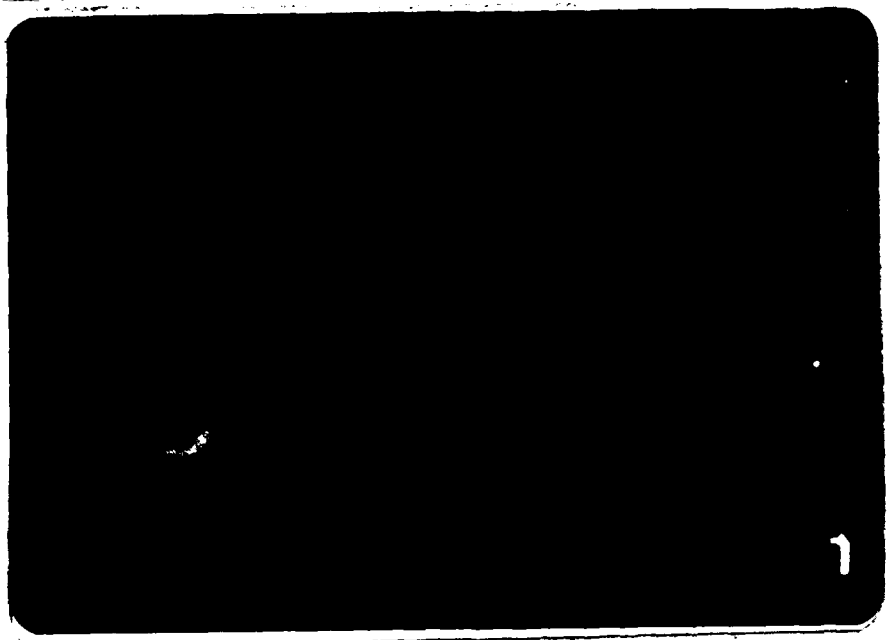


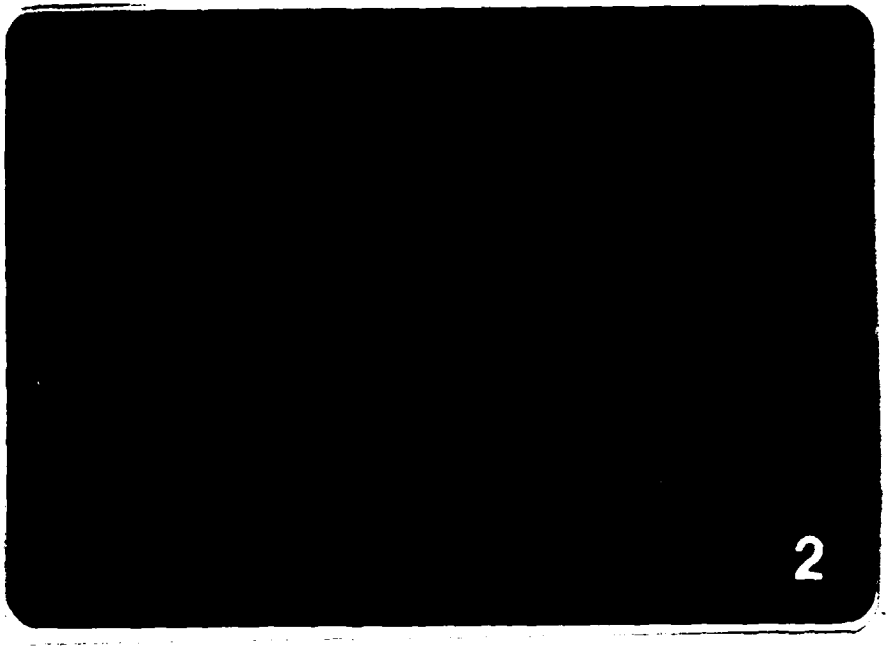
PHOTO INDEX

STRUCTURE E-1
MO. No. 20511

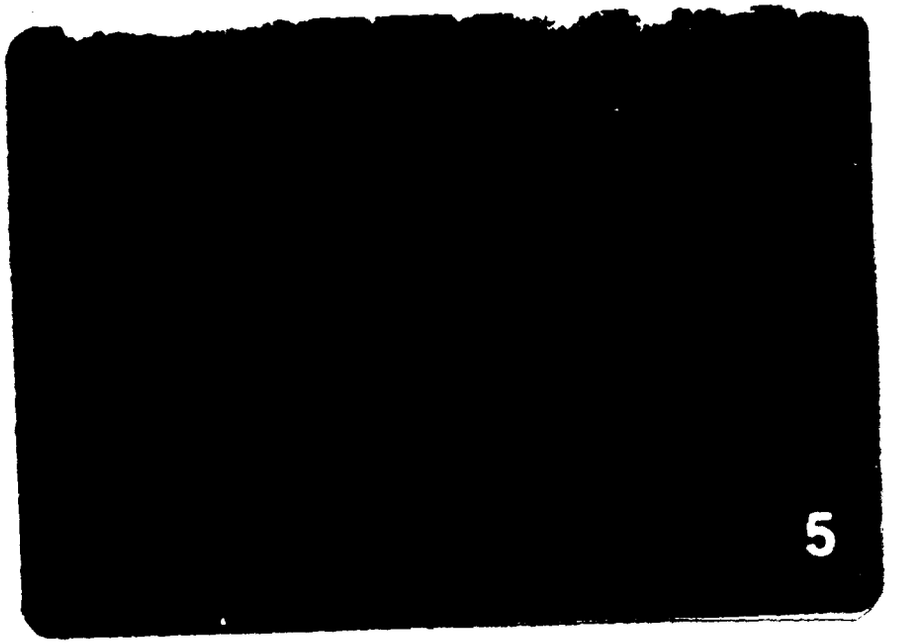
LIST OF PHOTOGRAPHS

Photo No.	Description
1	Aerial View of Dam
2	Aerial View of Dam
3	Closeup of Project Plaque
4	View of Crest (Looking East)
5	View of Upstream Embankment Face (Looking East)
6	View of Downstream Embankment Face (Looking West)
7	View of Lake from Crest (Looking North)
8	View of Inlet Structure
9	View of Spillway Pipe Outlet (Looking Southeast)
10	View of Spillway Pipe Outlet (Looking North)
11	View of Spillway Pipe Outlet (Looking Southwest)
12	View of Downstream Channel (Looking South)
13	View of Emergency Spillway (Looking Northeast)
14	View of Emergency Spillway (Looking Southeast)
15	Aerial View during Construction (August 1979)
16	Aerial View during Construction (August 1979)






LOST CREEK
WATERSHED PROJECT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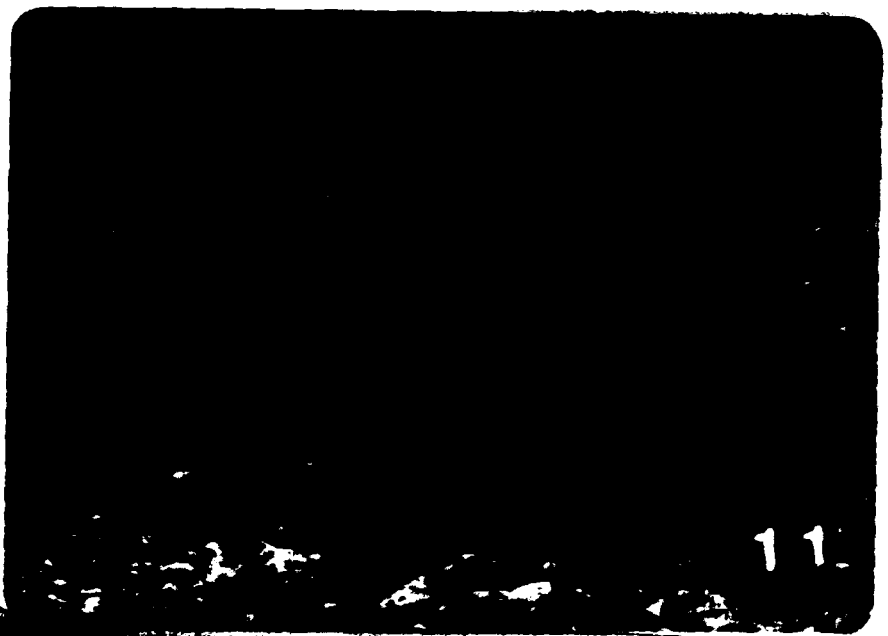
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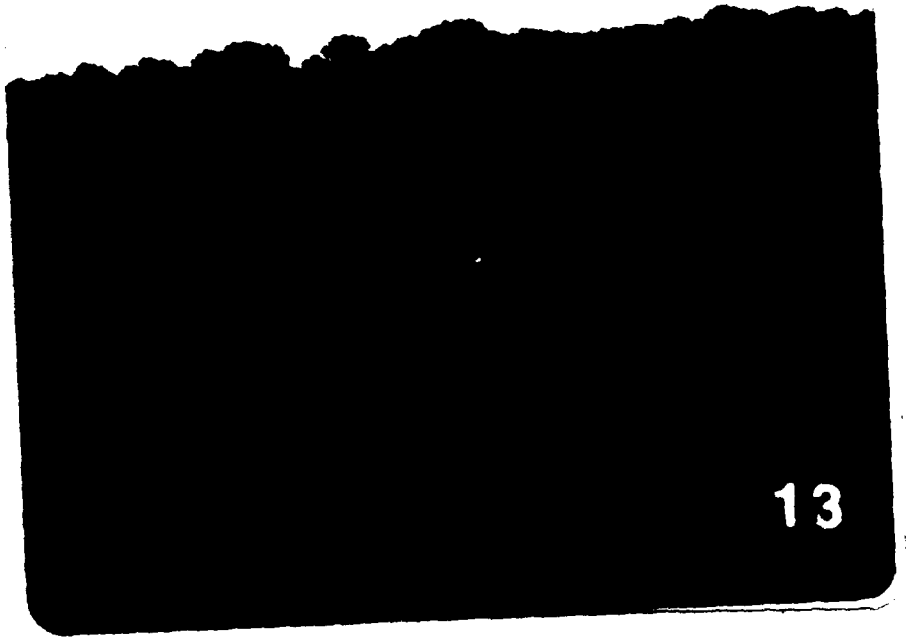
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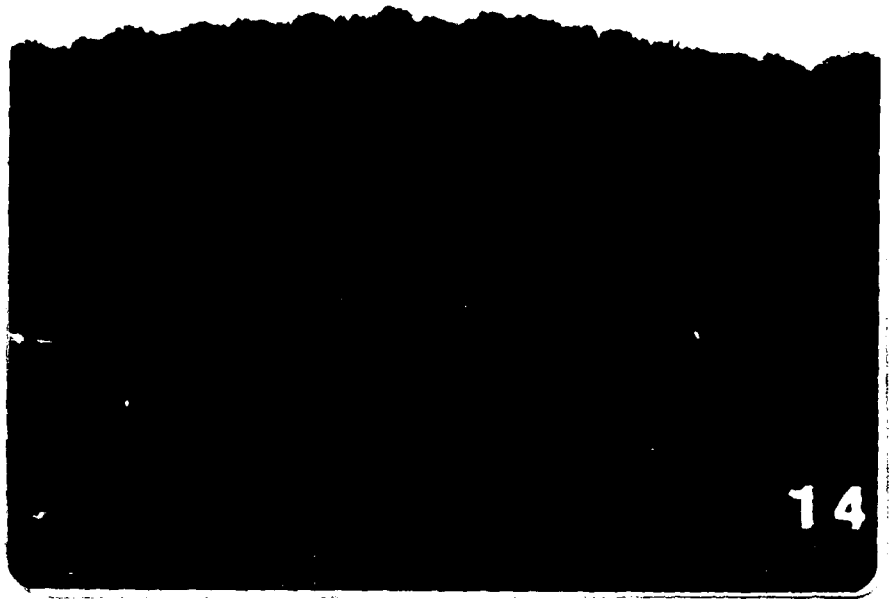
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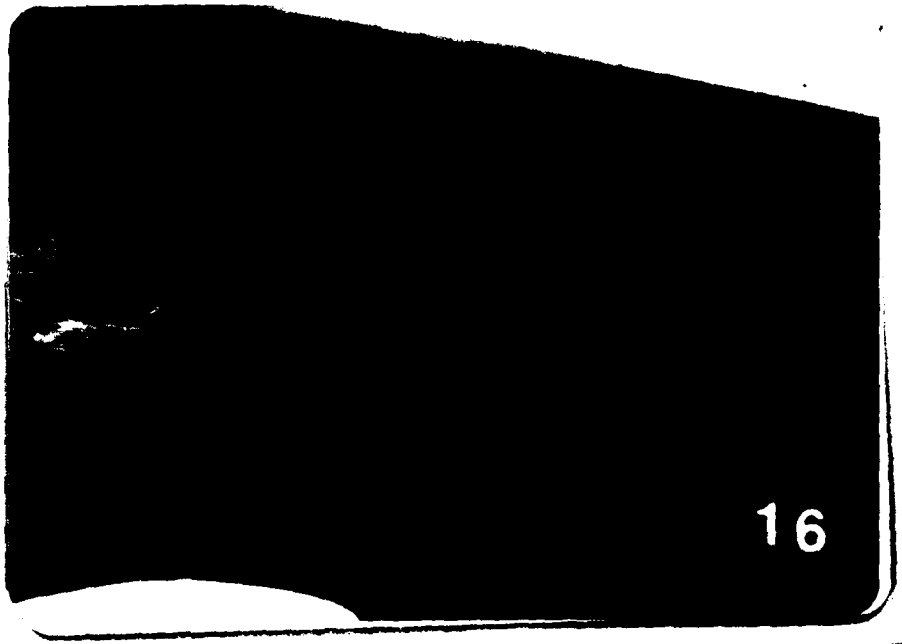
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